

National Aeronautics and
Space Administration

October 6, 2000

NRA-00-OES-08

RESEARCH ANNOUNCEMENT

CARBON CYCLE SCIENCE AND RELATED OPPORTUNITIES IN BIOLOGY AND BIOGEOCHEMISTRY OF ECOSYSTEMS AND APPLICATIONS

**Notices of Intent to Propose Due – November 1, 2000
Applications Proposals Due – January 4, 2001
All Other Proposals Due – December 14, 2000**

OMB Approval No. 2700-0087

**CARBON CYCLE SCIENCE AND
RELATED OPPORTUNITIES IN BIOLOGY AND
BIOGEOCHEMISTRY OF ECOSYSTEMS AND
APPLICATIONS**

**NASA Research Announcement
Soliciting Research Proposals
for
Period Ending
January 4, 2001 (for Applications)
and
December 14, 2000 (for Carbon Cycle Science, Terrestrial Ecology,
Land Cover and Land Use Change, and LBA-Ecology)**

**NRA-00-OES-08
Issued October 6, 2000**

**Office of Earth Science
National Aeronautics and Space Administration
Washington, DC 20546**

I. GOALS OF THIS NASA RESEARCH ANNOUNCEMENT (NRA)

This announcement offers opportunities for researchers to participate in NASA Earth Science Enterprise (ESE) research and development activities focused on the Global Carbon Cycle and related opportunities under the Terrestrial Ecology, Land Cover and Land Use Change (LCLUC), Applications, and LBA-Ecology research and development programs with a special emphasis on the use of remotely sensed observations.

Carbon Cycle Science is a priority research initiative for the U.S Global Change Research Program (USGCRP) and a research area singled out for augmented funding and emphasis within the NASA ESE program in 2001 and beyond. Under NASA's focus on Carbon Cycle Science, remote sensing-oriented research proposals are requested to: (1) identify, characterize and quantify global and regional sources and sinks for carbon, (2) develop, improve, and evaluate carbon cycle models, (3) use estimates of global and regional primary productivity to better understand carbon dynamics, and (4) develop new techniques, algorithms, and/or analytical approaches for deriving carbon cycle information.

The NASA **Terrestrial Ecology** Program has set aside resources to support additional carbon cycle research proposals under the topics identified above and will entertain other terrestrial ecology research and renewal requests.

The NASA **Land Cover and Land Use Change (LCLUC)** Program is seeking remote sensing-oriented proposals on synthesis of LCLUC case study results and to develop predictive scenarios of LCLUC that contribute to understanding of the carbon cycle. Proposals addressing the impacts of LCLUC on water resources and their implications for carbon, ecology, and biogeochemistry are also solicited.

The NASA **Applications** Program is seeking proposals that extend the benefits of ESE science, data, and technology to the broader user community through applications that meet the operational mandates or decision support requirements of public and commercial entities. Proposals should address applications objectives under the carbon cycle, LCLUC, and terrestrial ecology topics described above.

The Terrestrial Ecology Program also is seeking airborne remote sensing investigations involving U.S. aircraft for participation in the **Large Scale Biosphere–Atmosphere Experiment in Amazônia - Ecology (LBA-Ecology)** field campaign. Priority will be accorded those investigations that aid in "scaling up" from local to regional scales and that fill key data gaps for understanding regional carbon balance and trace gas fluxes.

Since many of the research issues identified above under carbon cycle science, terrestrial ecology, and, especially, LCLUC will require high spatial resolution land cover data, innovative and advanced uses of Landsat and EOS Terra data to address these issues are specifically encouraged under this NRA.

II. NASA'S EARTH SCIENCE ENTERPRISE

ESE is NASA's research enterprise to study the Earth as an integrated system, emphasizing observations made from the unique perspective of space together with underlying laboratory, field, theoretical, and modeling research. ESE also supports research and development in applications that extend the use of ESE science, data, and technology beyond the scientific community.

A. SCIENCE

ESE's new Science Implementation Plan (SIP) will call for research to address the following overarching question:

How is the Earth changing and what are the consequences for life on Earth?

The scientific strategy to address this immensely complex problem can be laid out as five fundamental questions, each raising a wide range of cross-disciplinary science problems:

- *How is the global Earth system changing?*
- *What are the primary forcings of the Earth system?*
- *How does the Earth system respond to natural and human-induced changes?*
- *What are the consequences of change in the Earth system for human civilization?*
- *How well can we predict the changes to the Earth system that will take place in the future?*

ESE has established the following research themes as priorities for the research program: biology and biogeochemistry of ecosystems and the global carbon cycle; the global water and energy cycle; ocean and ice in the Earth system; atmospheric chemistry, aerosols and solar radiation; and solid Earth science. The first of these themes, biology and biogeochemistry of ecosystems and the global carbon cycle, is the primary focus for this NRA. However, the atmospheric chemistry, aerosols and solar radiation theme is addressed significantly under the Carbon Cycle Science component, and there are clear and important connections to the global water and energy cycle theme and the ocean and ice in the Earth system theme.

The five fundamental science questions above define a logical progression in the study of global change, but each question covers a range of topics too broad to serve as a guide for program implementation. For this purpose, more specific research questions have been formulated and prioritized within each of the research themes. The second-tier research questions that are relevant to this NRA are:

- How are global ecosystems changing?

- What trends in atmospheric constituents and solar radiation are driving global climate?
- What are the changes in global land cover and land use, and what are their causes?
- How do ecosystems respond to environmental change and affect the global carbon cycle?
- What are the consequences of land cover and land use change?
- To what extent are changes in coastal regions related to climate change and sea-level rise?
- To what extent can future atmospheric chemical impacts be assessed?
- To what extent can future atmospheric concentrations of carbon dioxide and methane be predicted?

B. APPLICATIONS

The ESE Applications Program focuses on understanding priority issues that face public and private decision-makers, and determining how these issues can be addressed by the scientific and technical capabilities of ESE. Implementation of the program involves the use of information derived from remote sensing technology, along with other geo-spatial technology (e.g., GIS and GPS), ancillary data, and information for the purpose of improving decision-making by commercial enterprises, public agencies, public and private organizations, and/or the general public. To accomplish this objective, the Applications Program supports applications research focused on user needs and development activities to turn NASA-developed scientific and technical capabilities into information products and practical decision-support tools for solving near-term problems.

The process involves:

- understanding the ESE capabilities and assessing emerging science and technology results;
- understanding major issues, capabilities and priority needs of the "stakeholders" of the Applications Program; and,
- based upon an evaluation of the above capabilities and needs, designing specific programs and projects to apply emerging NASA science and technology results for the purpose of meeting user needs.

Applications projects are designed and implemented through vertically integrated teams. These teams include users; agencies of federal, state, and local governments; and commercial firms that share in the development costs and in the transition of the application into an on-going process free of long-term NASA technical and financial assistance.

Applications research solicited through this announcement will draw upon data sets acquired for, and science derived from, NASA sponsored research in carbon cycle science, terrestrial ecology and LCLUC. The applications research will extend work already completed in one of these discipline areas or propose to extend new research, but,

in either case, the application will provide a methodology through which specific findings in one or more of the three discipline areas may be used to derive information products that are routinely employed to meet operational mandates and/or in decision support.

III. RESEARCH OPPORTUNITIES

A. CARBON CYCLE SCIENCE

NASA research on the global carbon cycle is being conducted as part of the U.S. Carbon Cycle Science Program (CCSP) and involves (1) acquiring and analyzing remotely-sensed observations to derive improved estimates of regional and global carbon sources and sinks, including research to estimate global primary productivity, (2) developing and advancing carbon cycling models and coupled Earth system component models that include carbon, and (3) studying, developing, and deploying new methods and technologies for space-based observation of carbon cycle components and processes. NASA also supports process studies of carbon cycling dynamics, including major field campaigns, that aid in model development and the interpretation of remotely sensed data. NASA has identified new funding, to start in 2001, for enhanced, focused carbon cycle science.

Proposals are sought under the Carbon Cycle Science component of this NRA to address these four high priority carbon cycle research areas with a special emphasis on use of remotely sensed observations:

- identification, characterization, and quantification of global and regional sources and sinks for carbon and their temporal dynamics;
- development, improvement, and evaluation of carbon cycling models, including efforts to link land, ocean, and/or atmospheric component models with each other;
- advancement of our ability to estimate global and regional primary productivity and the use of these productivity estimates to better understand carbon dynamics; and
- development of new techniques, algorithms, and/or analytical approaches for extracting important carbon cycle information from remotely sensed data.

Research on the carbon cycle topics listed above falls within the objectives of the Synthesis and Modeling Project (SMP) of the U.S. Joint Global Ocean Flux Study (JGOFS). Investigators who are now participants in that program and wish to renew their research under the auspices of NASA carbon cycle science are encouraged to submit successor proposals (i.e., renewal proposals for JGOFS SMP awards due to expire in Fiscal Year 2001) in response to this NRA. Research on the carbon cycle topics listed above also falls within the objectives of the NASA ESE Terrestrial Ecology Program (see section III.B below). Effective use of Landsat data will be important for addressing these

carbon cycle topics. For this reason, resources previously available through the Landsat Program are being made available under this NRA for Landsat data utilization.

NASA anticipates funding approximately 25-30 proposals with annual budgets typically ranging between \$120-\$500K.

Additional background and detailed information on the topics of this Carbon Cycle Science research area are provided in Appendix A, section I.

B. TERRESTRIAL ECOLOGY

The goal of ESE's Terrestrial Ecology Program is to improve understanding of the structure and function of global terrestrial ecosystems, their interactions with the atmosphere and hydrosphere, and their role in the cycling of the major biogeochemical elements and water.

In fiscal year 2001, the Terrestrial Ecology Program will devote most of the funding that becomes available through normal program turnover (approximately \$1-2M for 2001) to support of Carbon Cycle Science under the topics outlined in section III.A of this NRA, with special attention directed to the support of research that explores the basic biophysics of new remote-sensing methods and information extraction approaches for inferring components of the carbon cycle.

Proposals to conduct research outside the scope of the carbon cycle science described in section III.A, but within the overall scope of the Terrestrial Ecology Program may be submitted, but funds have not been set aside specifically for such work and only the most highly rated and relevant of these proposals will be considered, as funds and priorities permit. All investigators desiring to submit successor proposals (i.e., renewal proposals for awards due to expire in Fiscal Year 2001) to continue current Terrestrial Ecology Program investigations should respond to this NRA.

Additional background and information on the Terrestrial Ecology research requested under this NRA is provided in Appendix A, section II.

C. LAND COVER AND LAND USE CHANGE (LCLUC)

NASA's Land Cover and Land Use Change (LCLUC) Program aims to develop and use NASA remote sensing techniques and technologies to improve understanding of human interaction with terrestrial ecosystems, and thus provide a scientific foundation for knowledge of the sustainability, vulnerability and resilience of terrestrial ecosystems.

Recent studies in the area of LCLUC, particularly local-scale, case studies of the causes and consequences of LCLUC, have yielded results that are now mature and ready for "synthesis" or for use in a first generation of "predictive" models and assessments. Proposals are sought under the LCLUC component of this NRA to conduct synthesis research (i.e., to compare, integrate, "scale up," and/or derive general principles) and to

develop model-based scenarios of future regional LCLUC and associated impacts based on the results of previously conducted LCLUC studies. Additional funds also are available to start several new projects in the area of LCLUC impacts on water resources and their implications for carbon, ecology, and biogeochemistry. All proposals to conduct LCLUC research will be expected to utilize remotely-sensed data.

Landsat data will be critically important for addressing these LCLUC topics because they provide observations of the Earth's surface at the scale at which changes in land cover and land use are occurring. For this reason, resources previously available through the Landsat Program are being made available under this NRA for Landsat data utilization. Use of Landsat data in each of the three LCLUC topics solicited above is strongly encouraged.

The LCLUC component of this NRA is seeking 7-10 proposals in the range of \$150-200K each per year.

Additional background and information on this LCLUC research topic is provided in Appendix A, section III.

D. APPLICATIONS

ESE's Applications Program fosters research and development to extend the benefits of ESE knowledge, data, and technology beyond the traditional scientific community. ESE applications are developed through research, validation, and implementation.

Applications research is the first step in moving science results, data, and advanced technology from the research environment into operational use. It requires the integration of multiple elements of related scientific research and technology development results into "Applications Systems" as required to meet specific, end-user defined, requirements. **Applications validation** is a proof of concept phase. It comprises testing and evaluation of experimental procedures and data (from operational or experimental instruments) to assure that information products derived from those procedures and data sets address user defined requirements and are suitable for an operational environment. **Applications implementation** is the use of data sets, procedures, and technology that have been validated to create a programmatic environment suitable for operations.

The Applications Program addresses research, validation, and implementation of applications in these four thematic areas: **community growth and infrastructure, disaster management, environmental assessment, and resource management.**

Proposals are sought under the Applications component of this NRA to conduct applications research, validation, and implementation addressing the Carbon Cycle Science, LCLUC, and Terrestrial Ecology topics of this NRA within the above four thematic areas. Applications projects that build upon research in these topical areas accomplished under previous ESE NRAs are encouraged. Applications proposals

will be considered in two categories: **research and validation (Type 1)**, and **validation and implementation (Type 2)**. Private sector participation in both proposal types is encouraged. Co-funding is also preferred as an indication of participant support and long term interest.

ESE expects to fund 2-4 Type 1 proposals and 3-9 Type 2 proposals at a maximum of approximately \$250K per year for a three year period; however, shorter duration proposals (i.e., 1-2 year periods of performance) requesting a higher level of annual funding are acceptable provided that the proposed objectives can be met and product(s) validated or implemented during the proposed period.

Additional background and detailed information on this Applications research and development area is provided in Appendix A, section IV. Potential investigators should note that evaluation criteria specific to Applications proposals are defined in Appendix A, section IV.C, and listed in full in Appendix B, section III.

E. U.S. AIRBORNE SCIENCE IN LBA-ECOLOGY

NASA's ecological research contribution to the Brazil-led Large Scale Biosphere-Atmosphere Experiment in Amazônia (LBA), called LBA-Ecology, has targeted 2002 for an airborne remote sensing campaign. The LBA-Ecology component of this NRA calls for remote sensing research investigations requiring the deployment of U.S. aircraft to South America to meet important observational needs of the ongoing program of research in LBA-Ecology. These observations should be obtained in concert with, and should complement, those from the space-based systems (e.g., Landsat, EOS Terra and Aqua) that are already addressed in the ongoing LBA-Ecology program. Of particular interest are airborne acquisitions that will play a critical role in research to "scale up" information and scientific understanding relevant to the terrestrial ecology and land cover change objectives of LBA-Ecology. Priority also will be accorded to studies focused on obtaining observations to fill key data gaps and reduce major scientific uncertainties in the understanding of regional carbon balance and trace gas fluxes.

The following approximate funding profile is available for LBA-Ecology airborne science: FY2001: \$0.75-1M; FY2002: \$2.0 M; FY2003: \$1.0-1.5M. (These totals include rough estimates of aircraft hours and some mission peculiar costs.) NASA anticipates funding approximately 3-7 new investigations. Participation of current LBA-Ecology investigators in these new proposals is permitted; it is expected that in most cases such participation could be achieved at no or minimal additional cost.

Background on LBA and details concerning LBA-Ecology airborne science priorities and the timing and requirements for the airborne campaign(s) are provided in Appendix A, section V. Proposers are encouraged to read this section of the NRA very carefully.

IV. GUIDANCE FOR PROPOSERS

A. AVAILABLE DATA SETS

NASA's policy is to work cooperatively with other U.S. government agencies and our international partners in the development of a comprehensive capability to observe and understand the Earth. In addition, both National and NASA policy require NASA to support private-sector investment in commercial space activities by committing the U.S. government to purchase commercially available goods and services. NASA will not develop a mission that in any significant way competes with or duplicates planned commercial capabilities.

NASA's Earth Science Enterprise has adopted commercial data purchases as a mainstream way of acquiring research-quality data, as these commercial capabilities become available. NASA encourages the use of commercially available data sets by Principal Investigators as long as it meets the scientific requirements and is cost-effective. When responding to a NASA Research Announcement the proposer should identify the commercial data sources intended for use and the associated cost.

Costs for any other types of required data also should be identified in the budget request. Information about data available under the Earth Science Scientific Data Purchase can be found at: <http://www.crsp.ssc.nasa.gov/databuy/dbmain.htm>

B. ELIGIBILITY

Participation in this NASA ESE research and applications opportunity is open to all categories of domestic and foreign organizations, including educational institutions, industry, non-profit institutions, NASA research centers, and other government agencies and laboratories (including Federally Funded Research and Development Centers).

Participation by non-U.S. institutions must be proposed within the specific guidelines described in Appendix C, which include a no-exchange-of-funds provision.

C. JOINT SCIENCE AND APPLICATIONS PROPOSALS

Joint science and applications proposals that combine applications objectives with Carbon Cycle Science, Terrestrial Ecology, or LCLUC science objectives are welcome. Proposals will be expected to meet all requirements in both NRA components (i.e., research areas) covered. They will be jointly reviewed (going through both the science and the applications peer review processes) and considered for joint selection and funding by the ESE Research and Applications Divisions.

D. AVAILABILITY OF FUNDS

A total of \$15-17M per year is available for the research solicited under this NRA. This total combines funds set aside by ESE for new Carbon Cycle Science with funds derived

from the integration of currently existing program elements, including Terrestrial Ecology, Biological Oceanography (JGOFS SMP), Land Cover and Land Use Change, Landsat, and Applications. Funds for these programs in 2001 and beyond have not yet been appropriated; NASA plans to make resources available for this research through its core research and analysis budget.

Projects may be partially funded within fiscal years (i.e., incremental funding) to minimize uncoded carry over. Because awards are unlikely before spring of 2001, and less than a full year of Fiscal Year 2001 funds will be needed to initiate the new projects selected through this NRA, some budget profiles that are highest in the first year (with significant non-recurring costs in the first 6-8 month increment) can be considered.

Guidelines specifying ranges for annual funding levels have been provided for several components of this NRA and should be followed for proposals responding wholly to those components, and without significant use of Landsat data. However, proposals that combine topics and activities across components of the NRA (e.g., joint science and applications research; Carbon Cycle Science with strong use of Landsat data; intensive Landsat data processing focused on a major LCLUC research question) may exceed these guidelines. Such proposals should provide an exceptionally strong and compelling justification for the requested funding level and clearly indicate in the budget the funding requirements that map to each NRA component.

E. PROPOSAL SUBMISSION AND REVIEW

1. Notice of Intent to Propose

Notices of intent (NOI) to propose are requested from all prospective proposers to this NRA and are due by no later than 4:30 p.m., EST, November 1, 2000. These NOIs will be used to expedite the NASA planning for peer review. Proposers are strongly encouraged to submit their NOI via email to OESresponse@hq.nasa.gov. If this is not possible, NASA will accept a FAX copy containing the information described in Appendix F and sent to (202) 479-0511.

NOIs for LBA-Ecology should specify the airborne sensors and platforms requested or to be offered in the proposal, the sites/regions/countries to be over-flown, and the approximate time of coverage, to the nearest month(s), desired.

2. Proposal Content and Format

Details on the proposal format, content, and order of materials are provided in Appendix B and Appendix C. Proposers are urged to read the information in these appendices carefully and to follow the specific guidelines. **Proposers should take care to note that differences among the requirements for proposals to be submitted under different components (i.e., program areas) of this NRA are noted in bold, italicized type in Appendix B.**

3. Period of Performance

Proposals will be considered for periods of performance of up to three years.

4. Review Process

The review process and the evaluation criteria to be used are described in Appendix B, section III. **Please note that there are different evaluation criteria for the different components (i.e., program areas) of this NRA.**

Final decisions will be made promptly and proposers will be notified either by electronic mail or surface mail, or both. Final decisions for each of the components (i.e., Carbon Cycle Science, Terrestrial Ecology, LCLUC, Applications, and LBA-Ecology) of this NRA will be made and announced separately, on differing schedules. Proposers will receive anonymous copies of the written evaluations for their proposals.

5. Proposal Submission Dates

Proposals may be submitted at any time during the period ending at 4:30 p.m., EST, on the following dates:

Carbon Cycle Science, Terrestrial Ecology, LCLUC, and LBA-Ecology
Airborne Science proposals due: December 14, 2000
Applications proposals due: January 4, 2001

Joint science and applications proposals should adhere to the earlier of the two due dates.

Announcement of final selections for all components of this NRA is anticipated by no later than spring, 2001. Award start dates are anticipated for 1-2 months after the selection is announced.

F. ADDITIONAL INFORMATION

Appendix A provides background and detailed technical information concerning the research requested under each of the five research components of this NRA. Appendix B provides amendatory guidance to the general guidelines for responding to NASA Research Announcements contained in Appendix C specific to this NRA, information on required proposal format and content, and the proposal evaluation criteria. Appendix C also contains instructions for foreign participation in this opportunity. Appendix D contains examples of the proposal cover sheet, required institutional declarations, and a budget summary form. Appendix E provides the URL addresses for accessing World Wide Web home pages with information relevant to this NRA. If electronic access is not available to the prospective proposers, a hard copy of relevant reference(s) can be requested by calling (202) 479-9030 and leaving a voice mail message. Please leave your full name and address, including zip code, and your telephone number, including area code. Appendix F provides instructions for submitting notices of intent to propose

electronically. *Prospective investigators are urged to read the information in all of the appendices carefully and to follow the specific guidelines therein carefully.*

The following items apply only to this announcement.

Identifier: NRA-00-OES-08

Submit Proposals to: Carbon
NASA Peer Review Services, Code Y
500 E Street, Suite 200
Washington, DC 20024-2760

For overnight mail delivery purposes only the recipient telephone number is (202) 479-9030.

Number of Copies Required: 12

NASA Selecting Official: Director, Research Division
(for Carbon Cycle Science, LCLUC, Office of Earth Science
Terrestrial Ecology, and LBA-Ecology)

NASA Selecting Official: Director, Applications Division
(for Applications) Office of Earth Science

Obtain Additional Information from: Dr. Garik Gutman (Lead: Carbon and LCLUC)
Mail Code YS
NASA Headquarters
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Your interest and cooperation in participating in this opportunity are appreciated.

Original Signed by

Dr. Ghassem R. Asrar

Associate Administrator for

Office of Earth Science

Enclosures:

Appendix A – Background and Technical Description of Research Opportunities
Solicited

Appendix B - Amendatory Guidance to the General Guidelines Contained in Appendix C
and Applicable Only to this NRA and Instructions for Proposers

Appendix C - Instructions for Responding to NASA Research Announcements

Appendix D - Proposal Cover Sheet, Required Declarations, and Budget Summary Form

Appendix E - Electronic Addresses

Appendix F - Instructions for Submitting Notices of Intent to Propose Electronically

APPENDIX A
BACKGROUND AND TECHNICAL DESCRIPTION OF RESEARCH
OPPORTUNITIES SOLICITED

I. OPPORTUNITIES IN CARBON CYCLE SCIENCE

A. BACKGROUND

Carbon Cycle Science is a priority research initiative for the U.S Global Change Research Program (USGCRP) and a research area singled out for augmented funding and emphasis within the NASA ESE program in 2001 and beyond.

1. Carbon Cycle Science in the New NASA ESE Science Implementation Plan

NASA's ESE has drafted a new Research Strategy which has been reviewed recently by the National Academy of Sciences. It provides a strategy for setting ESE priorities and describes the content and future directions for the overall program and each of its research themes that will be elaborated in the new ESE Science Implementation Plan (SIP). Earth system science research requires a coordinated national and international effort to acquire global data sets and assess the effects of global environmental change. NASA's contribution is focused on providing data and information derived from space-based remote sensing systems capable of observing the Earth at multiple scales and across the electromagnetic spectrum. Airborne and *in situ* observations, intensive field campaigns, process studies, data and information systems, and models are important to NASA's contribution because they are essential for interpreting and making full use of satellite observations. The strategy is to realize an optimal balance among systematic and exploratory measurements from space, airborne and *in situ* observations, basic process studies and coordinated field experiments, and modeling. The scientific requirements for carbon cycle research that will be specified in the SIP can be summarized as follows.

Requirements identified for carbon cycle science include systematic, global observations of (1) ocean color at moderate spatial resolution (as is now available from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS), the Moderate-Resolution Imaging Spectroradiometer (MODIS) of the Earth Observing System (EOS), and the Sensor Intercomparison and Merger for Biological and Interdisciplinary Ocean Studies (SIMBIOS) project), (2) vegetation indices, vegetation biophysical properties, and land cover at moderate spatial resolution (as is now available from the Advanced Very High Resolution Radiometer (AVHRR), and MODIS), and (3) land cover and land use at high spatial resolution (as is now available from Landsat). Landsat's seasonal, high-resolution coverage of the Earth's land surface and coastal regions is particularly well-suited for characterizing and classifying land cover to assess terrestrial carbon stocks. Advances in data processing are within reach for making it possible to produce large regional image composites and quantitatively evaluate changes in carbon dynamics.

Requirements identified for new or exploratory data sets include: vegetation height or above-ground biomass (to estimate terrestrial carbon stocks), information on vegetation

response and biomass recovery following disturbance (to reduce uncertainties related to carbon storage in regrowing vegetation and to investigate the consequences for carbon cycling of land cover and land use changes), measurements of atmospheric carbon dioxide concentrations (to resolve regional sources and sinks of carbon dioxide when analyzed using inverse modeling approaches), information on the freeze-thaw status of high latitude ecosystems (to provide accurate estimates of growing season length and the timing of the spring thaw that can be used to improve estimates of annual carbon uptake), and observations at very short-time scales of coastal ocean processes at high resolution (to improve our understanding of carbon dynamics in coastal and coral reef ecosystems). The SIP also will note a desire for additional information to discriminate terrestrial and marine functional groups and/or species assemblages, to quantify photosynthetic efficiency through measures of fluorescence, and to characterize vertical structure of planktonic ecosystems in the ocean's surface layer.

Requirements will be identified in the SIP for field campaigns, *in situ* observations, laboratory studies, case studies, and process studies (1) to investigate comprehensively Earth system responses to multiple stressors and disturbances, (2) to investigate in detail the forcings and consequences of land cover and land use change in the regions of the world experiencing the most change or where anthropogenic stresses are likely to increase most rapidly, (3) to understand better the controls on carbon uptake and release by global ecosystems, (4) to understand the effects of interrelated changes in carbon, water, and nitrogen, phosphorus, silicon, iron, and other nutrients, and (5) to improve local, national, and regional carbon budget and emissions estimates. Additionally, research to improve ecological, biogeochemical, atmospheric, oceanic, carbon budget, and land use models will be a priority for ESE, as will be research to develop a next generation of coupled land-atmosphere, ocean-atmosphere, land-ocean, and, ultimately, land-ocean-atmosphere models.

2. USGCRP Carbon Cycle Science Implementation Plan

NASA research on the global carbon cycle is being conducted as part of the U.S. Carbon Cycle Science Program coordinated by the Interagency Working Group on Carbon Cycle Science (under the U.S. Global Change Research Program (USGCRP)). The interagency group has adopted many of the recommendations in the report of an external Carbon and Climate Working Group entitled "A U.S. Carbon Cycle Science Plan."

The goal of the U.S. interagency Carbon Cycle Science Program is to provide critical scientific information on the fate of carbon in the environment and how cycling of carbon might change in the future. The following scientific questions are being used to organize the U.S. Carbon Cycle Science Implementation Plan:

- What has happened to the carbon dioxide that has already been emitted by human activities?
- How do land management and land use, terrestrial and ocean dynamics, and other factors affect carbon sources and sinks over time?

- What will be the future atmospheric carbon dioxide concentration resulting from environmental changes, human actions, and past and future emissions?

Additional information on the U.S. Carbon Cycle Science Program and the report, "A U.S. Carbon Cycle Science Plan," are provided at: <http://www.carboncyclescience.gov/>

3. NASA's Role in the U.S. Carbon Cycle Science Program

NASA's primary contribution to the U.S. Carbon Cycle Science Program involves (1) acquiring and analyzing remotely-sensed observations to derive improved estimates of regional and global carbon sources and sinks, including research to estimate global primary productivity, (2) developing and advancing carbon cycling models and coupled Earth system component models that include carbon, and (3) studying, developing, and deploying new methods and technologies for space-based observation of carbon cycle components and processes. In addition, NASA contributes supporting process studies of carbon cycling dynamics, including major field campaigns, that aid in model development and the interpretation of remotely sensed data.

These contributions require research that maps to the five fundamental questions of ESE's scientific strategy as follows: (1) documentation of the variability in the global carbon cycle, (2) quantification of the relative importance of the human (e.g., land use, pollution), climatic, carbon dioxide, and nutrient forcings on Earth system carbon dynamics, (3) characterization of the responses by marine and terrestrial ecosystems to these forcings, (4) delineation of the consequences of environmental changes on carbon cycling, and (5) prediction of the future course of the global carbon cycle and the distribution of carbon among its terrestrial, oceanic, and atmospheric components.

NASA depends on the other USGCRP agencies for the vast majority of carbon process studies; research on soil and deep ocean carbon dynamics; research to derive paleoecological and paleoclimatic information on past carbon dynamics; the deployment of, and analysis of data from, *in situ* observational networks and carbon inventories; and the conduct of manipulative field experiments. NASA relies on strong partnerships with several other agencies (e.g., NSF, DOE, NOAA) to advance carbon cycle modeling and in the conduct of cross-cutting integrative analyses and scientific support of carbon-related assessments.

B. CARBON CYCLE SCIENCE REQUESTED

Proposals are sought under the Carbon Cycle Science component of this NRA to address these four high priority carbon cycle research areas with a special emphasis on use of remotely sensed observations:

- identification, characterization, and quantification of global and regional sources and sinks for carbon and their temporal dynamics,

- development, improvement, and evaluation of carbon cycling models, including efforts to link land, ocean, and/or atmospheric component models with each other,
- advancement of our ability to estimate global and regional primary productivity and the use of these productivity estimates to better understand carbon dynamics, and
- development of new techniques, algorithms, and/or analytical approaches for extracting important carbon cycle information from remotely sensed data.

These research areas have been chosen to ensure that NASA applies its unique capabilities to meeting ESE's primary commitments to the U.S. Carbon Cycle Science Program as detailed in section I.A.3 above. The first three of these topics address NASA's commitment to using remote sensing observations for estimating regional and global carbon sources and sinks and advancing carbon cycle modeling. The fourth topic was chosen to encourage basic remote sensing science research focused on advancing data analysis techniques and enhancing the theoretical underpinning for new, exploratory approaches, measurements, or data sets that have potential to provide critical information on carbon cycling dynamics. This supports NASA's primary commitment related to the development of new methods and technologies, but does not call for technology development as such. Technology development in support of carbon cycle science will be addressed under future opportunities to participate in the NASA ESE program (e.g., the Instrument Incubator Program (IIP)).

It is expected that research supported under these topics will make important use of data from the current satellites acquiring systematic observations, namely Landsat 7, EOS-Terra MODIS, SeaWiFS, and AVHRR as well as other appropriate current satellite data sets (e.g. SAR, other EOS-Terra sensors). Landsat data utilization is particularly encouraged because carbon cycle research will require high spatial resolution land cover data to quantify areal extent of sources and sinks and to derive process understanding. Advanced approaches to data processing for Landsat data that enable rapid analysis of regional and global Landsat data sets in the context of the research and applications objectives for Carbon Cycle Science are of interest. Where improvements in data processing procedures or advanced algorithm development are clearly essential to answering carbon cycle science questions, this type of research proposal is welcome. In such cases, proposals will be expected to include appropriate scientific, data processing, and/or algorithm development expertise in a research project that addresses a particular carbon cycle science question.

Modeling studies are not required to use satellite data sets to be successful under this NRA, although use of satellite data as input to models or for model evaluation is strongly encouraged.

Basic research relevant to these topics that is directed toward advancing NASA's scientific readiness to evaluate the potential of new and exploratory measurements or data

sets to provide critical information on carbon cycling dynamics is very strongly encouraged.

Each of the four carbon cycle research topics is elaborated in the sections below, and examples of the types of studies desired are provided. These examples are not intended to be exhaustive, and other types of relevant studies may be proposed.

1. Global and Regional Sources and Sinks for Carbon

The U.S. Carbon Cycle Interagency Working Group's science implementation plan identifies an urgent need for better information on the global distribution of carbon sources and sinks and how they are changing. Because of sparseness of observations and an incomplete knowledge of the processes involved, locations which serve as carbon dioxide and methane sources or sinks to the atmosphere are not known with precision. Research on global sources and sinks of carbon will support current efforts to identify and quantify the missing carbon sinks, now thought to be in Northern Hemisphere terrestrial ecosystems and/or the Southern Ocean. It also will complement this research on sinks by providing the global context and a foundation for characterizing changes in sources and sinks as they evolve over time. Space-based remote sensing is probably the only means to obtain the sustained, synoptic, systematic observations needed for this purpose, but much basic research is still required to learn how well differing types of carbon sources and sinks can be delineated and tracked over time, as well as to determine the limits to quantifying carbon sources and sinks using remote sensing.

Examples of the types of investigations NASA is seeking are: (1) the development and analysis of time-series of satellite imagery for important carbon source or sink regions; (2) research on the impacts of disturbance, stress, and land-use and land-cover change on local and regional carbon balances; (3) research into the physical, chemical, and biological processes regulating the sources and sinks of carbon; and (4) development of scaling methodologies and approaches for coupling local processes to regional and global fluxes. Proposals submitted may be either global in scope or focused on regions with demonstrated, important carbon sources or sinks.

2. Carbon Cycle Modeling

Models are primary tools for integration and scaling of information across ecosystems and for prediction of future conditions. At present, the best carbon cycle models are limited to only one of the major carbon cycle components – typically, either the terrestrial, marine, or atmospheric component or, alternatively, carbon dioxide or methane. Current climate models do not incorporate a dynamic understanding of the carbon cycle, and are not able to reproduce patterns of variability. To predict future atmospheric carbon concentrations, we must understand and portray in Earth system models the mechanisms that control the components of the carbon cycle. We also must be able to characterize spatial and temporal variability in carbon cycling dynamics. Thus, new and improved models are required to improve the portrayal of carbon cycle dynamics and their controlling processes and to couple dynamically the cycling of carbon

with other Earth system processes (e.g., water cycling). Emphasis should be placed on model testing with increasingly rigorous model-data comparisons, when possible.

Examples of the types of research investigations NASA is seeking are: (1) improving the portrayal of carbon cycle components in various kinds of models; (2) modeling that integrates global ocean carbon data from *in situ* measurements, ocean color, or other proxy observations; (3) models addressing how regional terrestrial carbon sources and sinks, their interannual variability, and the human influences on them affect the global carbon cycle; (4) inverse and forward modeling of atmospheric carbon dioxide and methane concentrations and transport processes; (5) coupling of *in situ* network data with remote sensing data to improve and extend carbon cycle models across landscapes, regions, and the globe; (6) development of models and/or assimilation systems to simulate prior evolution or to predict future atmospheric concentrations of carbon dioxide and methane; and (7) development of coupled land-ocean-atmosphere carbon cycling models.

3. Global and Regional Productivity

Research to produce estimates of global and regional primary productivity patterns and their temporal dynamics based on remotely-sensed parameters is a continuing ESE priority because of its direct relevance for understanding food production, ecosystem health, and the global carbon cycle. For the purposes of this NRA, the focus is on connections to the global carbon cycle. Proposals are requested to develop a means of relating satellite-derived estimates of net primary productivity (NPP) to fluxes of carbon to the atmosphere, to higher trophic levels, and to the deep sea.

Progress toward understanding global ocean productivity, as revealed by the time series of ocean color measurements, is critically dependent upon contemporaneous global observations of physical variables and processes, and new research in the use of dynamic topography and winds to improve estimates of productivity is of interest. Also, studies are needed on the biological determinants to carbon fluxes, that is, the role that plankton community structure plays in regulating the transport of carbon to the deep sea, or to the atmosphere. For terrestrial ecosystems, research is needed to relate estimates of net primary productivity (NPP), derived from remotely sensed vegetation indices, and measures of net ecosystem productivity (NEP) or net biome productivity (NBP) acquired by eddy covariance flux towers and flux aircraft, respectively, to each other and to regional carbon dynamics.

Additionally, changes in biodiversity due to habitat loss and fragmentation, land use change, invasive species, disease, inputs of nutrients and pollutants, or other causes can affect ecosystem productivity and, therefore, have an impact on carbon dynamics. Innovative research to explore such relationships is of interest.

Examples of the types of research investigations NASA is seeking are: (1) development of methodologies for relating satellite-derived ocean color, vegetation index, net primary productivity, or biomass estimates to carbon fluxes; (2) development of scaling strategies, algorithms, or improved models for estimating NPP, NEP and NBP and/or inter-relating

these productivity measurements; (3) exploration of the relationships between productivity patterns, carbon dynamics, and biodiversity.

Research proposed here should not attempt to replicate work currently being done by the MODIS, SeaWiFS, and SIMBIOS teams, but rather should plan to build upon what is already being done and/or explore new directions.

4. New Approaches for Carbon Cycle Information

The ESE encourages research to develop new approaches to and techniques for the analysis of remotely sensed data. The Carbon Cycle Science component of this NRA seeks innovative ideas for extracting new and important information about the global carbon cycle from remote sensing data. New techniques, algorithms and approaches are of interest, as are innovative ways of combining existing approaches or methodologies. Research that explores the basic biophysics of new remote-sensing methods and develops advanced techniques for information extraction to infer components of the carbon cycle is of particular interest.

Investigators proposing under this topic should take care to identify in their proposal the carbon cycle science question they are addressing and to point out the relevance and potential payoff of the proposed techniques for answering that carbon cycle science question.

Examples of the types of investigations NASA is seeking are: (1) new techniques for extracting carbon cycle information from existing satellite data sets (e.g., enhancement of Landsat data processing algorithms to perform automated navigation, analyses of long time series, compositing of large volumes of data, calibration and cross-calibration with other sensors, masking operations, atmospheric adjustments, and topographic corrections) or new approaches for combining existing satellite data or data products to derive important carbon cycle information, (2) evaluation of how global atmospheric carbon dioxide measurements could be used to quantify regional sources and sinks of carbon, including remote sensing simulation studies to investigate in detail the physical and chemical basis for alternative remote sensing measurement concepts; (3) approaches for characterizing and quantifying above-ground vertical structure and biomass of terrestrial vegetation and for analyzing vegetation biomass recovery following disturbance, (4) techniques for utilizing information on freeze-thaw dynamics in cold regions to improve estimates of annual terrestrial carbon uptake, and (5) improved methods for estimating particulate organic carbon in ocean surface waters and its vertical flux to depth in the ocean.

Development of new technologies or instruments is not requested and will be considered non-responsive to this NRA.

II. OPPORTUNITIES IN THE TERRESTRIAL ECOLOGY PROGRAM

A. BACKGROUND

The goal of ESE's Terrestrial Ecology Program is to improve understanding of the structure and function of global terrestrial ecosystems, their interactions with the atmosphere and hydrosphere, and their role in the cycling of the major biogeochemical elements and water. This program addresses the role of terrestrial ecosystems in responding to and affecting global environmental change and in the global carbon cycle. The key science questions from the ESE SIP addressed by the Terrestrial Ecology Program are:

- How are global ecosystems changing?
- How do ecosystems respond to environmental change and affect the global carbon cycle?
- To what extent can future atmospheric concentrations of carbon dioxide and methane be predicted?

The research approach combines the use of remote sensing to observe terrestrial ecosystems and their responses; field campaigns and process studies to elucidate ecosystem function; and ecosystem and biogeochemical cycling models to predict responses. Current research within the program emphasizes analysis of ecosystem responses to change, terrestrial primary productivity, carbon cycling, and land-atmosphere interactions and terrestrial ecosystem feedback to climate and atmospheric chemistry.

B. TERRESTRIAL ECOLOGY RESEARCH REQUESTED

1. Carbon Cycle Science

In fiscal year 2001, the Terrestrial Ecology Program will devote most of the funding that becomes available through normal program turnover to support of carbon cycle science under the topics outlined in section I of this appendix, with special attention directed to the support of research that explores the basic biophysics of new remote-sensing methods and information extraction approaches for inferring components of the carbon cycle. Effective use of Landsat data will be important for addressing certain topics in terrestrial ecology, and proposals offering such will be welcome.

2. Related Terrestrial Ecology Research

Proposals to conduct research outside the scope of the carbon cycle science described in section I, but within the scope of the overall goal of the Terrestrial Ecology Program may be submitted, but funds have not been set aside specifically for such work and only the most highly rated and relevant of these proposals will be considered, as funds and priorities permit. **All investigators desiring to submit successor proposals (i.e.,**

renewal proposals for awards due to expire in Fiscal Year 2001) to continue current Terrestrial Ecology Program investigations should respond to this NRA.

III. OPPORTUNITIES IN THE LAND COVER AND LAND USE CHANGE PROGRAM

The ESE LCLUC Program aims to develop and use NASA remote sensing techniques and technologies to improve understanding of human interaction with terrestrial ecosystems, and thus provide a scientific foundation for knowledge of the sustainability, vulnerability and resilience of terrestrial ecosystems. In so doing, a major goal of the LCLUC Program is to further the understanding of the consequences of land-cover and land-use change on ecosystem goods and services, the carbon and water cycles, and the management of natural resources. The key science questions from the ESE SIP addressed by the LCLUC Program are:

- What are the changes in global land cover and land use, and what are their causes?
- What are the consequences of land cover and land use change?

The emphasis of the LCLUC program is on addressing research topics with practical societal benefits and relevance. The LCLUC program strongly encourages synergy among biogeochemistry, the physical sciences, socioeconomic influences, and remote sensing. Improved scientific understanding developed through LCLUC research can provide a foundation for improved management for sustainability and resilience of terrestrial ecosystems.

A. LCLUC RESEARCH TOPICS REQUESTED

Recent studies funded by NASA and other programs in the area of LCLUC, particularly local-scale, case studies of the causes and consequences of LCLUC, have yielded results that are now mature and ready for "synthesis" or for use in a first generation of "predictive" models and assessments. Research that compares, integrates, or "scales up" results from individual case studies and attempts to derive principles concerning the causes and consequences of LCLUC is now possible. Also, it now seems possible to develop model-based scenarios of future regional LCLUC and associated impacts, both as a means of testing this understanding as well as to generate testable hypotheses about future LCLUC change. Investigators desiring to conduct such research, including those who wish to submit successor proposals (i.e., renewal proposals for LCLUC research awards that have recently expired or are about to expire in Fiscal Year 2001) are invited to respond to this NRA.

Changes in land cover and land use, affecting carbon cycling and biogeochemical processes, are closely related to water processes at the land surface. NASA wishes to complement current research within the LCLUC program on forest cover, carbon dynamics, and disturbance with studies that address interactions with water cycling,

particularly in semiarid regions. Therefore, additional funds have been identified to start several new projects in the area of LCLUC impacts on water resources and their implications for carbon, ecology, and biogeochemistry. All proposals to conduct LCLUC research will be expected to utilize remotely-sensed data.

High-resolution remote sensing data will be critical for identifying LCLUC pathways and impacts, but there remains the need to consider how high-resolution, local-scale observations feed into the regional view needed to assess the importance and magnitude of LCLUC. The availability of higher spatial resolution sensors, geographically comprehensive data acquisition strategies, and frequent observations coupled with expanding capacities for investigators to analyze large data volumes promises a better merging of these approaches in future research.

1. Case Study Synthesis

The processes of land cover and land use change are often studied at the local scale using analysis of high spatial resolution (tens of meters) satellite data combined with intensive collection of *in-situ* data. From these studies comes insight into the processes at the site or local level. The LCLUC program encourages the scaling up of these studies to a regional scale to determine their regional significance. Multi-resolution satellite data can facilitate this process. For example, "hot spots" of LCLUC over the globe can be first detected using Advanced Very High Resolution Radiometer (AVHRR) and Moderate-Resolution Imaging Spectroradiometer (MODIS) data and then further investigated with high-resolution Landsat data. Commercially available data with even higher resolution (1-5 meters), can then be employed to verify results and to make further refinements. Synthesis of results across existing local-scale studies provides the possibility for developing a broader understanding of the processes and for making conceptual advances. This cross project synthesis stage is often missing from individual research projects.

Proposals are requested to conduct synthesis research involving multi-resolution, comparative approaches that integrate results from multiple case or process studies and address the drivers or impacts of LCLUC. Synthesis research also is requested to determine if generally applicable rules or models of land cover and land use change can be developed based on the results of past case or process studies of LCLUC.

2. Predictive Scenarios of LCLUC

Once an improved understanding of the processes of land cover and land use change has been gained it is possible to simulate and assess future land cover and land use changes. Dynamic modeling of land cover and land use change, based on an understanding of the processes involved, allows for improved simulation beyond a more simplistic projection, extending recent trends. With an understanding of the processes involved, current land cover and land use change and recent history derived from satellite data provide a departure point for regional predictive scenarios and assessments. Modeled prediction and assessment of different scenarios of land cover and land use change and their

associated impacts currently fall firmly in the research domain but can provide a useful tool for the development of land management strategies in the future.

Proposals are requested to develop regional predictive scenarios of LCLUC and the associated impacts, e.g. on ecosystem vulnerability, using remotely sensed data together with socioeconomic or climate scenarios or forecasts. These future scenarios should be driven by an understanding of the processes that contribute to documenting patterns of land cover and land use change.

3. LCLUC Impact on Water Resources

Changes in land cover and land use are closely interrelated with water processes at the land surface. Water availability to a large part determines the distribution of agriculture. Changes in precipitation regimes can result in changes in land use, and, in turn, land use affects water processes and resources at local to regional scales. Changes in land use can alter run-off, ground water, soil erosion, and water quality. These changes in water processes in turn affect carbon cycling and biogeochemistry producing ecological effects that need to be carefully studied. Increasing demand for and inadequate supplies of water are now drawing attention to land use and water management. Thus, there is an urgent need for improved scientific understanding of the impacts of land use change on water resources as well as the effects on changes in water cycling on land use that would provide information for sustainable water management.

Proposals are requested to carry out studies utilizing remote sensing data to address LCLUC impacts on water resources in relation to human vulnerability, drought susceptibility or changes in water quality. Proposers are encouraged to extend this research on effects on the water cycle to implications for carbon, ecology, and biogeochemistry. The focus of this LCLUC topic is on semiarid regions, where human livelihood and land use are closely tied to water supply. Some semiarid regions are undergoing rapid social, economic or demographic changes and there is a need for a stronger scientific underpinning to resource management. Priority will be given to studies of a regional scale and significance. The regions of interest to this NRA include: the US and its territories; Southern Russia and the Central Asian Republics of the former Soviet Union where semiarid arable lands have been subject to rapid socioeconomic changes; and the Middle East where land use impacts on water management are an important driver for ecological sustainability and political decisions. Regional-scale proposals that demonstrate strong linkages to in-country scientists involved in research and applications on the topic will receive priority.

4. Additional Considerations

Landsat data will be critically important for addressing the above three LCLUC topics because they provide observations of the Earth's surface at the scale at which changes in land cover and land use are occurring. Use of Landsat data in each of the three LCLUC topics solicited above is strongly encouraged. Advanced approaches to data processing for Landsat data that enable rapid analysis of regional and global Landsat data sets in the

context of the research and applications objectives for LCLUC are of interest. Where improvements in data processing procedures or advanced algorithm development are clearly essential to addressing these LCLUC issues, this type of research proposal is welcome. In such cases, proposals will be expected to include appropriate scientific, data processing, and/or algorithm development expertise in a research project that addresses a particular LCLUC science question.

IV. OPPORTUNITIES IN THE APPLICATIONS PROGRAM

A. BACKGROUND

ESE's Applications Program fosters research and development to extend the benefits of ESE knowledge, data, and technology beyond the traditional scientific community. ESE applications are developed through research, validation, and implementation

Applications research is the first step in moving science results, data, and advanced technology from the research environment into operational use. It requires the integration of multiple elements of related scientific research and technology development results into "Applications Systems" as required to meet specific, end-user defined, requirements. In order to accomplish this objective, applications research involves a close interface with the scientific research and technology development program areas of ESE. ESE applications research exploits the unique capabilities of ESE science, data, and technology to create new, geo-spatial, information products of potential utility to the public and private sectors. For this NRA, applications research may include algorithm development if supporting evidence is provided that existing algorithms are not adequate to meet the information product requirement. Instrument development is not covered by this NRA.

Applications validation is a proof of concept phase. It comprises testing and evaluation of experimental procedures and data (from operational or experimental instruments) to assure that information products derived from those procedures and data sets address user defined requirements and are suitable for an operational environment. Validation includes verification, calibration, and evaluation of existing algorithms, data, instrumentation, and other technology.

Applications implementation is the use of data sets, procedures, and technology that have been validated to create a programmatic environment suitable for operations. Operational generation of information products is not included.

The Applications Program addresses research, validation, and implementation of applications in these four thematic areas:

- **community growth and infrastructure** includes transportation, infrastructure and utilities, cultural and recreational resources, issues of

quality of life in the community, and human impacts as they relate to land use.

- **disaster management** encompasses natural disasters such as wildfires, volcanic eruptions, earthquakes, severe weather and floods, as well as environmental issues related to human health. The topic area involves identifying and monitoring geo-spatial features subject to involvement in natural disasters prior to and during natural disaster events. The information is used by agencies responsible for responding to disaster events and the public to prepare for, and mitigate, such events.
- **environmental assessment** includes air, water, and land environments and the effect of natural and man-made changes in the landscape on the environment. It also includes ecosystems, i.e., analysis of biodiversity loss, ecosystem analysis, and wildlife habitat analysis including fragmentation studies.
- **resource management** includes all natural resources, renewable and non-renewable: agriculture, rangeland, forestry, fisheries, fossil fuels, extraction, and renewable energy.

B. APPLICATIONS PROPOSALS REQUESTED

Proposals are sought under the Applications component of this NRA to conduct applications research, validation, and implementation addressing the Carbon Cycle Science, LCLUC, and Terrestrial Ecology topics of this NRA within the above four thematic areas. Example applications topics include, but are not limited to, a) environmental assessment - monitoring regional changes in soil carbon using *in situ* measurements and/or models to measure or estimate soil carbon (carbon cycle science) and remote sensing techniques to scale up the estimates for large areas or b) disaster management - assessment of wildfire potential derived from integration of remote sensing based information on vegetation type and hydration (LCLUC). Applications projects that build upon research in these topical areas accomplished under previous ESE NRAs are encouraged. LBA-Ecology is not a potential research area for applications research and development under this NRA.

Applications proposals will be considered in two categories:

- Research and validation (Type 1)
- Validation and implementation (Type 2)

Type 1 (research and validation) proposals will be based on application requirements established by, or through collaboration with, the potential user. Research will be performed to develop the methodology, algorithms, etc to meet the application requirements. *Active participation by the end user(s)* in defining the application requirements, working with the team during research and evaluating results during development *is essential*. Letters of endorsement are not sufficient, in themselves, to indicate the level of involvement of the end-user in the project. The proposal must describe the activities in which the end-user is, and will be, involved; the nature of the

participation; and how the participation can be monitored. Collaborators should demonstrate a vested interest in the application and the results from the research. The proposal must include validation so that by the conclusion of the proposal term, the application is ready for implementation.

Type 2 (validation and implementation) proposals will begin with an application for which the methodology is known, but not necessarily validated, and carry the application through validation and implementation. Implementation is considered complete when the application has been adopted into the operations of a private or public entity. Type 2 proposals *may exclude validation*, but must, in such cases, indicate when and how validation was performed. Type 2 proposals must meet the same requirements as Type 1 proposals **and**: 1) provide a plan for operational implementation and 2) show cost sharing by an end user.

Private sector participation in both proposal types is encouraged. Co-funding is also preferred as an indication of participant support and long term interest.

C. EVALUATION CRITERIA FOR APPLICATIONS PROPOSALS

The measure of success in this effort, defined by the Applications Program, is the implementation of routine and sustained use of the methodology and/or products to meet the end-user's information mandates and/or assist, on a regular basis, policy makers in their decision making process. NASA, as a research organization, will not participate in the operations of a public or private entity, but NASA will assist such entities in demonstrations of applications research, validation, and implementation. The intention of the solicitation is to assist end-users to overcome the technical risk and costs associated with the development phase. As development reaches a more mature stage, NASA will phase out ongoing financial support and leave meeting routine support requirements to its project partners. *"End-user" includes public and commercial entities.*

There are several evaluation criteria that are specific to Applications proposals, and quite different from those for the science proposals. In particular, the following criteria relating to the quality, effectiveness, and appropriateness of the applications approach will be applied:

- (1) **National Importance** (issues with highest potential socioeconomic impact and "payoff;" user/market "pull" driven and directed at priority end-user problems),
- (2) **Pervasiveness** (commonality, transportability, and perceived "long-term duration" of application; use of public/private user interest groups, associations, professional societies to distribute project results and ensure successful transportability),
- (3) **Uniqueness of NASA ESE Contribution** (draws/builds on unique science, applications and technology strengths of ESE; cannot be adequately addressed by the private sector or other Federal, state and local agencies),
- (4) **Partnership Investment/Involvement** (indication of significant commitment by non-NASA partner, "risk-sharing partnerships" among end-users, researchers, and public or private service providers, i.e., vertically integrated applications development teams),
- (5) **Documentable Results** (process to measure outcome-based measures of success (i.e., difference between existing baseline and comparable baseline after application of project results); process to determine performance metrics (input, output, outcome, and impact)), and
- (6) **Commercial Impact** (potential positive impact on economic end users or commercial remote sensing industry).

Under the cost evaluation factor, special attention will be given to the acceptability of the financial risk, the existence of a favorable ratio of investment with the potential savings or improved decision-making, and the affordability and practicality of the proposed application. Potential investigators should review the full set of evaluation criteria for Applications proposals in Appendix B, section III.

The maximum term for Type 1 and Type 2 proposals is 3 years. Investigators may propose for shorter terms. For example, a proposal may be submitted for one year to complete research and validation. It could then be followed by another proposal, at the end of the year, for application implementation. The follow-on proposal would be eligible for a term of up to three years.

V. AIRBORNE SCIENCE IN LBA-ECOLOGY UTILIZING U.S. AIRCRAFT

A. LBA

The Brazil-led Large Scale Biosphere-Atmosphere Experiment in Amazônia (LBA) is an international, multi-disciplinary research program designed to provide new knowledge of the climatological, ecological, biogeochemical, and hydrological functioning of Amazônia, the impact of land use change on these functions, and the interactions between Amazônia and the entire Earth system. NASA is making a substantial contribution to LBA focused on understanding the effects of tropical forest conversion, regrowth, and selective logging on carbon storage, nutrient dynamics, trace gas fluxes, and the prospect

for sustainable land use in Amazônia. This field campaign, involving contributions from both the Terrestrial Ecology and LCLUC Programs of NASA's ESE, is called LBA-Ecology.

LBA employs a multi-scale approach that considers the effects of forest conversion at scales ranging from the local, site-level scale to that of the entire Amazonian region. LBA is being conducted during 1998-2003, with observations running for 3-5 years to capture seasonal and interannual variations. Its field research is carried out along two transects spanning gradients from wet, aseasonal forests to relatively dry and seasonal forests or savannas (Figure 1). Continuous or periodic observations of a core set of measurements (e.g., carbon dioxide, water, and trace gas fluxes; trace gas concentrations; micrometeorological conditions; vegetation and soil properties) are made along the transects in predominant land uses for that location. Time series of remote sensing observations are compiled for past and current satellite sensors. The local-scale measurements and results of process studies are combined with remotely sensed data and other geographically extensive data sets to derive regional-scale understanding. Airborne observations will play a key role in this scaling approach. Models also will be used for testing understanding, extending it across scales, and predicting future responses. Additional information on LBA, in particular the LBA-Ecology Experiment Plan, can be found at: <http://lba-ecology.gsfc.nasa.gov/lbaeco/> Additionally, the LBA web site may be consulted: http://www-eosdis.ornl.gov/lba_cptec/

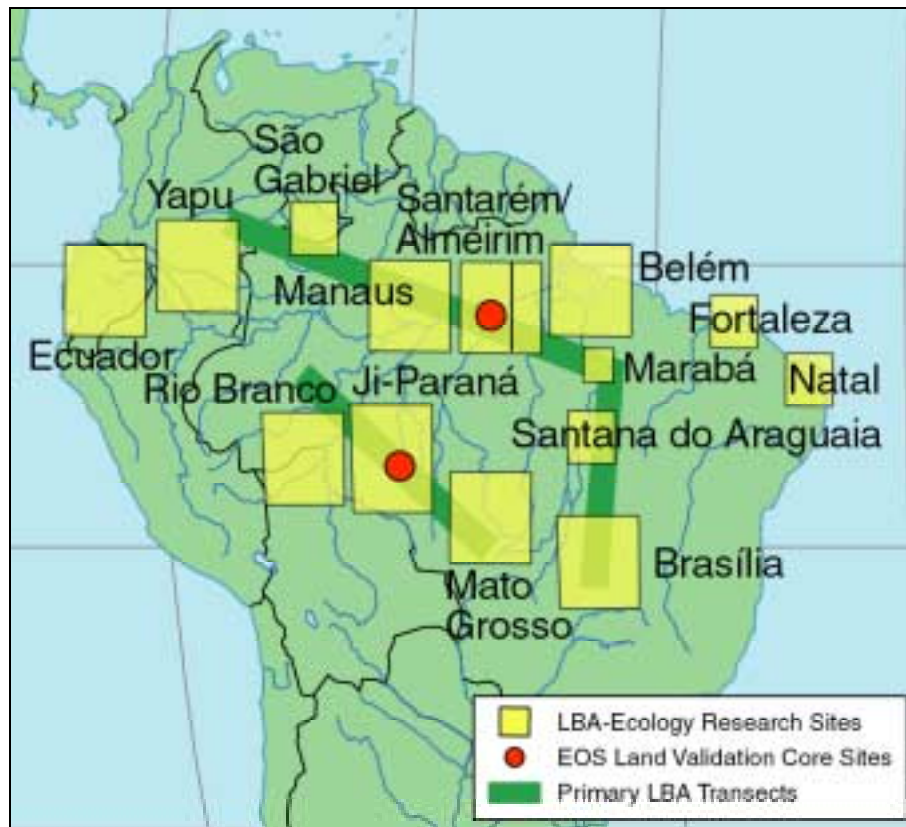


Figure 1

B. U.S. AIRBORNE SCIENCE INVESTIGATIONS IN LBA-ECOLOGY

1. Background

The earliest planning for LBA included a requirement for airborne remote sensing, including the use of research sensors on U.S. platforms. However, when investigations for LBA-Ecology were first solicited, the U.S. and Brazil were not ready to enter into an agreement in support of U.S. aircraft flying over Brazilian territory. Therefore, solicitation of the airborne science requiring U.S. aircraft platforms has been delayed until now. It is anticipated that significant portions of the NASA-sponsored airborne science covered in this announcement will be conducted within the territory of Brazil. The conduct of new U.S. airborne science investigations within the territory of Brazil and under the auspices of LBA is subject to and contingent upon approval by appropriate elements of the Brazilian Government. NASA and the Brazilian Ministry of Science and Technology intend to execute a new implementing arrangement for LBA to add a U.S. ecological remote sensing component to LBA. This NRA is being issued and proposals are being requested prior to proposing this agreement and receipt of formal endorsement of and approval by the Brazilian Government of these proposed U.S. airborne science research campaign(s). This is because information about the types of investigations to be conducted and the instrumentation to be deployed is needed for the agreement. NASA is confident that the necessary Brazilian Government approvals will be obtained. However, NASA provides notice to all prospective offerors and potential investigators seeking to submit proposals pursuant to this announcement, that NASA reserves the right to make no selections and no awards for those research activities that do not receive endorsement and approval from the Brazilian Government.

2. Role of Airborne Science in LBA-Ecology

It is anticipated that airborne acquisitions will play a critical role in the "scaling up" of important observations of interest for terrestrial ecology and land cover and land use change in Amazônia. Currently, investigations are underway utilizing ground-based and satellite-based observations to address the effects of changes in land cover on the functioning of the Amazon. The application of experimental airborne synthetic aperture radar (SAR), lidar, hyperspectral and/or multi-angle measurements from aircraft platforms could, for example, provide essential information for evaluating approaches to quantify vegetation recovery and biomass change following forest clearing and various forms of land use. It also could enable more accurate biophysical parameter assessments over regions and enable validation of satellite algorithms for such assessments from space across Amazônia.

In March, 1999, LBA scientists participated in a workshop to define LBA remote sensing requirements for land surface properties. Their workshop report includes airborne remote sensing requirements for LBA-Ecology and provides a basis for the investigations requested in this NRA. This report can be accessed at: <http://lba->

ecology.gsfc.nasa.gov/lbaeco/Investigator_Info/reports.htm ; its pertinent recommendations are summarized and updated below.

a. Types of Airborne Remote Sensing Observations of Interest for LBA-Ecology

The airborne observations of highest priority for LBA-Ecology are those that have potential to fill key data gaps and reduce major scientific uncertainties in the understanding of regional carbon balance and trace gas fluxes. These may involve use of radar, profiling lidar, or multi-angle sensors to obtain observations of canopy structure that can be used to generate improved estimates of biomass and/or secondary growth stage in re-growing forests and selectively logged areas. Other observations of interest are: land cover type; biophysical properties of land cover; surface moisture status/inundation; and topography. Observations that provide intermediate resolution measurements that can be used to relate *in situ* observations to satellite observations and/or as a means of scaling understanding across landscapes and up to the regional scale are of special interest as well.

With regard to land cover and carbon dynamics, the following Amazonian land cover analyses are of interest for LBA-Ecology: refined discrimination of Amazonian vegetation types; refined discrimination of agricultural cover types; correct classification or quantification of re-growth stages, age classes, or biomass densities; identification of areas experiencing selective logging and quantification of the biomass losses in them; and discrimination of the areal extent and duration of inundation in seasonally flooded forests. Other land cover applications of interest include: use of radar remote sensing (for applications more traditionally served by optical data) to avoid problems of cloud cover in the wet season and smoke in the dry season and use of optical and microwave methods to characterize wet and dry season vegetation properties (referred to as "phenology" in the LBA remote sensing report).

The research topics listed above do reflect major scientific priorities, but are not exhaustive, and there may be other promising applications; investigators are welcome to propose and justify the significance of such observations and analyses.

Radar Observations

Examples of the types of tasks for which synthetic aperture radar (SAR) data might be expected to play a useful role in LBA-Ecology are:

- Measurement of canopy height and canopy volume for estimating above-ground biomass in vegetation recovering from disturbance.
- Generation of digital elevation models (DEM) in support of Shuttle Radar Topography Mission (SRTM) data already acquired.
- Characterization of the areal extent and duration of flooding in seasonally inundated forests and wetlands.

- Cross-calibration of SAR data from differing sensors (satellite and airborne), including archived and new orbital SAR data.
- Resolving issues of scale and resolution.
- Refining classifications derived from other sensors (e.g., optical sensors).

High quality estimates of above-ground biomass will be very important to LBA. Experiments seeking to improve above-ground biomass estimates should include areas of active (legal) logging as well as areas with undisturbed forest, and consider the availability and quality of biometry and allometric studies. These seem to be best for the sites near Manaus and Santarém where a number of collaborative opportunities exist.

Digital elevation models are widely needed, particularly at the main LBA sites (Manaus, Santarém, Rondonia). SRTM-derived DEM data of high quality will soon be available for LBA, and cross-comparisons between SAR-derived DEM and SRTM data are desired. Airborne SAR data also are needed for cross-calibration of archival orbital SAR data.

Lidar Observations

Lidar remote sensing may play a useful role in LBA-Ecology by acquiring measurements of canopy height and canopy vertical profile for estimating above-ground biomass in forest vegetation. These measurements are especially needed for the principal LBA research sites along the two transects. Airborne lidar data coupled with extensive ground reference data over key LBA sites could serve as a test-bed for improving the derivation of biomass measures and canopy layering structure.

Hyperspectral Observations

Examples of the types of tasks for which hyperspectral data may be expected to play a useful role in LBA-Ecology are:

- Improved land-cover characterization and discriminability
- Biophysical definition of land-cover classes
- Biophysics and spectral characterization of the phenological signal (primarily wet season / dry season differences)
- Improved calibration and validation of other optical sensor data and products

Accurate land-cover characterization is a critical requirement for many of the LBA investigations. By necessity, remote sensing will play a crucial role in scaling up detailed local measurements to larger regions across a range of temporal and spatial scales. Scaling and modeling efforts require both accurate land-cover classification and direct biophysical definition of Amazonian cover types. Airborne hyperspectral systems have the potential of making significant contributions to such scaling and mapping activities in LBA.

Multi-season (i.e., wet and dry season) acquisitions of hyperspectral data are of interest to sharply improve the spectral and biophysical definition of variation within land-cover categories. Two approaches should be considered for acquiring multi-temporal data. In the first approach, a hyperspectral system could be deployed: (1) in the late dry season, when many canopies have undergone significant leaf loss; and (2) in the very early dry season, when leaves are mature and peak canopy greenness occurs. An alternate approach is to substitute time for space by taking advantage of differences in seasonality across the Amazon region. For example, flights could be acquired over a northwest-southeast gradient across the Amazon Basin, with early dry season samples occurring in the southeast and late dry season farther to the northwest.

In addition to direct spectral characterization, airborne hyperspectral data can be used for extensive verification and validation processes for the suite of new products from the EOS Terra satellite, specifically from MODIS, MISR, and ASTER, and for model applications.

Multi-angle Remote Sensing Observations

Examples of the types of tasks for which multi-angle data might play a useful role in LBA-Ecology are:

- Improved land-cover characterization
- Biophysical definition of land-cover classes
- Estimates of aerosol optical depth for atmospheric correction of remotely sensed data products
- Use of structural observations and shade to estimate canopy volume and/or biomass
- Improved calibration and validation of other optical sensor data and products

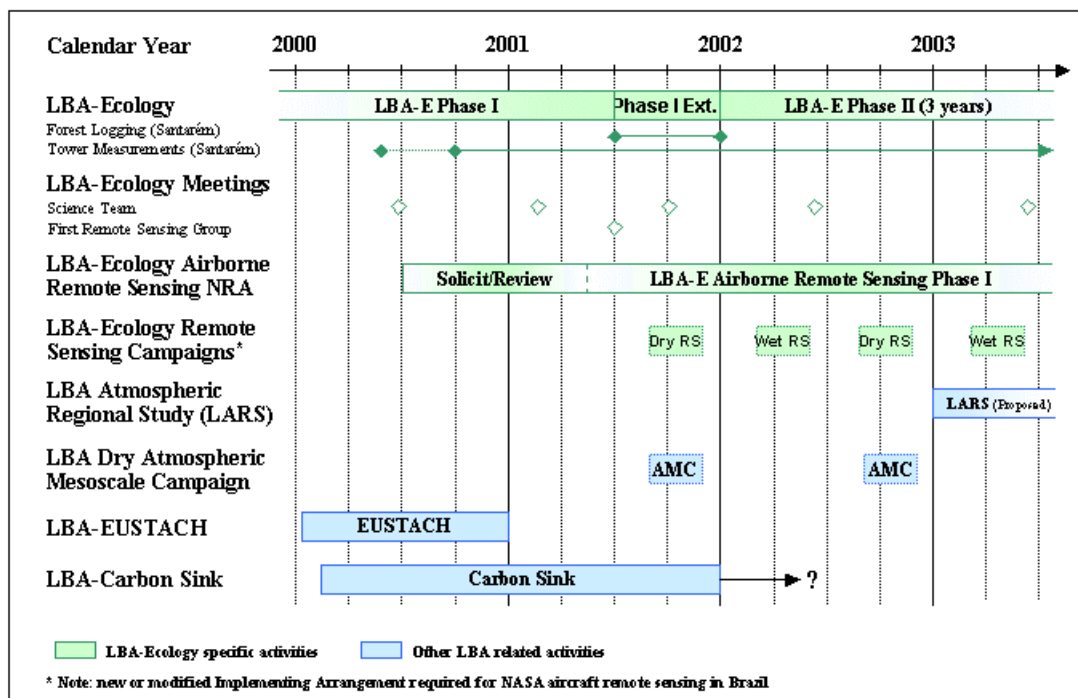
Again, scaling and modeling studies in LBA-Ecology will require both accurate land-cover classification and direct biophysical definition of Amazonian cover types. Airborne multi-angle observational systems have the potential to contribute to such scaling and mapping activities in LBA. Multi-angle observations of canopy structural attributes (e.g., gap fraction, crown density and spacing) have potential to improve classifications and canopy physiological and/or biophysical models. Multi-angle observations of atmospheric constituents (i.e., aerosols) can provide needed information on particle properties and atmospheric optical depth for remote sensing data correction and for analysis of the effects of biomass burning in the region.

3. General Flight Planning

NASA has not pre-selected any aircraft or sensors for participation in LBA-Ecology airborne remote sensing. Neither have the exact dates for or number of aircraft deployments been set. However, the LBA remote sensing workshop report detailed some

general requirements that have been used to develop a tentative plan and to reserve scarce aircraft resources. The planning schedule is shown in Figure 2. Note that while places are held for two wet and two dry season campaigns, only one each is believed to be required. Also, at least for some applications, it may be possible to catch both wet and dry season conditions in a single deployment by exploiting seasonal differences across Amazônia. For planning purposes, time has been reserved on both the NASA DC-8 and the NASA ER-2. Proposers should not assume, however, that these aircraft will be included automatically in LBA-Ecology remote sensing. Also, it is possible that other platforms could end up flying the selected sensors. All aircraft and sensors to participate in the LBA-Ecology U.S. aircraft remote sensing campaign(s) must be proposed in response to this NRA or, for certain aircraft platforms, be selected as a result of the instruments selected for participation.

Figure 2 - LBA-Ecology Time Line



The most likely scenario for deployment of the DC-8, if proposed and selected, would be for peak wet season (some period during March – June) and peak dry season (some period during September – November) deployments in 2002. The most likely scenario for the ER-2, if proposed and selected, might be for optimal optical sensor viewing conditions during the period May-August, 2002. The LBA-Ecology Science Team, in coordination with NASA LBA-Ecology and Airborne Science managers and the managers for other aircraft that might be selected to participate, will set the final schedule once the airborne remote sensing investigations have been selected and a schedule for the agreement(s) between the U.S. and the selected South American countries can be determined.

It is expected that most airborne remote sensing data will be acquired over specific LBA research sites (e.g., flux tower locations, land use study sites) and along the two LBA transects (see Figure 1). Other sites may be proposed, provided they address important LBA-Ecology remote sensing research questions and take advantage of the unique capabilities offered by airborne sensors.

Proposers should be aware of certain complexities that may arise while flying in South America. Flight lines that cross national boundaries can create difficulties in obtaining approvals and may not be possible. If data are required over more than one country, and can be obtained by means of a sequence of single country deployments, that option would be preferred. Brazilian law requires that original data remain in the country, so it may be necessary to leave the original data tape, or an exact copy made in-country, in Brazil prior to the aircraft leaving the country. Because of this law, Brazil does not allow for direct transmission of data from the aircraft to a satellite data relay system. Sensors that cannot comply with these requirements/restrictions will be considered under this NRA only if an acceptable accommodation can be successfully negotiated with Brazil. Brazilian law requires an observer on foreign remote sensing aircraft, and proposers should expect to comply with this requirement as well. (In the past, it has been possible to obtain a waiver for the ER-2, but this must be done well in advance and close supervision on the ground is still required.)

Proposers will be expected to comply with all host country laws and regulations for scientific experiments using aircraft. In addition to the above requirements, these may include submitting detailed paperwork to obtain required approvals; providing accommodation for host country observer(s) on all flights; following all directions of ground and airborne control; allowing the observer(s) or ground control to abort the mission for any reason; accepting inspection by host country authorities and their supervision of data delivery and/or of the copying of tapes; and providing, well in advance of the proposed deployment, detailed information on the instruments and aircraft to be used.

4. Proposals Requested for LBA-Ecology

Research proposals for airborne remote sensing investigations requiring the deployment of U.S. aircraft in support of the objectives of the LBA-Ecology Project are solicited. NASA requests studies that will apply advanced airborne sensors deployed on U.S. aircraft platforms to meet important observational needs of the ongoing program of research in LBA-Ecology. These observations should be obtained in concert with, and should complement, those from the space-based systems (e.g., Landsat, EOS Terra and Aqua) that are already addressed in the ongoing LBA-Ecology program. Of particular interest are airborne acquisitions that will play a critical role in research to "scale up" information and scientific understanding relevant to the terrestrial ecology and land cover change objectives of LBA-Ecology. Priority also will be accorded to studies focused on obtaining observations to fill key data gaps and reduce major scientific uncertainties in the understanding of regional carbon balance and trace gas fluxes.

Each proposal should take care to justify the unique observational capabilities of the airborne sensor, to provide a rationale for the scientific importance of the observations to be obtained for LBA-Ecology science, and to describe exactly how the data will be used to help answer a high priority LBA-Ecology question (LBA-Ecology questions are detailed in Chapter 2 of the LBA-Ecology Experiment Plan at: http://lba-ecology.gsfc.nasa.gov/lbaeco/About_the_Project/explan/explanv1/explanv1.htm). Investigations proposed should either specify the remote sensing instrument(s) to be deployed and suggest an appropriate U.S. aircraft platform or offer both the instrument(s) and the aircraft platform (if they are theirs to offer) in their proposal.

Each proposal should address a specific LBA-Ecology research question or set of questions and include a data analysis plan and/or data product that will answer the question(s). The data analysis and/or data product development components of these airborne science proposals may be either wholly conducted within the airborne science investigation itself or involve collaborations with existing LBA investigators and investigations. Proposals involving collaborations should describe how the collaborating teams will work together in the management plan and, if necessary, should include low-cost budget requests for the collaborators. Proposals requiring extensive ground-truth observations should either include those activities and costs within the proposal or indicate in the proposal how such observations will be available from existing LBA investigations. Special emphasis should be given to the availability of adequate ground reference information and the geometrical rectification of the data.

Proposals should specify required and preferred sites, spatial coverage, timing of observations, and if possible, provide an estimate of the number of flight hours required to collect the data. Costs for instrument integration on the requested aircraft platform should be addressed.

All of these proposals must include a data management plan, describe sensor performance assessment and calibration, and address validation. All proposals should indicate the proposer's willingness to comply with all host country laws, regulations, and approval processes, and describe how data delivery, observer, and other requirements will be met.

5. Collaboration Requirements

a. General

Proposers are encouraged to develop appropriate collaborations of all kinds. Combinations of U.S. and international scientists are encouraged, as are collaborations among scientists from government, industry, and academia. Joint, collaborative proposals are welcome, as are parallel proposals for complementary activities. Proposers are cautioned to not create so broad or diffuse a collaboration that reviewers cannot evaluate the proposal at a reasonable level of technical detail or understand its management plan. Proposers are encouraged to note linkages among proposals being

submitted in parallel, but are cautioned to not create critical dependencies on other proposals such that each cannot be evaluated as a separable unit of research.

b. Host Country Collaborations

Brazilian law requires that scientists from outside of Brazil participating in expeditions within Brazil have a Brazilian counterpart. A Brazilian institution with recognized expertise in the research area must take responsibility for the participation of the foreign investigators. For this reason, as well the obvious importance of involving scientists with needed expertise and familiarity with the local environment, proposers are strongly encouraged to involve Brazilian and/or other host country collaborators (e.g., scientists, students, and technicians) in their responses to this announcement. Proposers should provide evidence that they have taken appropriate measures to facilitate the involvement of their host country collaborators.

Proposals without host country collaborations will be considered in response to this announcement, but if accepted, will be accepted for a six-month definition phase pending identification of an acceptable host country counterpart. The LBA Central Office in Brazil will be available to help match foreign participants with appropriate host country collaborators. If, at the end of this six-month definition phase, an acceptable collaboration has been identified, the award will be confirmed for an execution phase under the same terms as proposals selected without a definition phase. If an acceptable collaboration has not been identified at the end of six months, the award will be allowed to expire at the end of its initial performance period.

6. Training and Education Requirements

In addition to the research to provide a scientific basis for sustainable development in Amazônia, NASA's South American partners in the planning of LBA value the opportunity that this major interdisciplinary research program offers to enhance their internal research capacities. Amazônia is a very large region with very few environmental and global change scientists, and scientists at Amazonian institutions have many responsibilities, but limited resources. Capacity enhancement and training will be key to the involvement of these scientists and to the recruitment of students and technicians from the region, and are, therefore, explicit objectives for LBA. Each proposal submitted for participation in LBA-Ecology is expected to have a training and education component. This component may involve training of students and technicians at all levels, exchanges of scientific personnel with South American institutions, teaching of courses, developing course materials, participation in training workshops, transfer of appropriate technological skills and capabilities, and/or providing guest lectures and seminars. Training and educational activities should be detailed either within the technical section of the proposal or in the management plan.

7. Additional Guidelines

Airborne sensors potentially available for LBA-Ecology include AVIRIS, AIRSAR, several of the EOS sensor airborne simulators, other Principal Investigator controlled instruments, and commercial sensors.

Proposals for aircraft remote sensing investigations that utilize host country aircraft are not being solicited at this time (this type of investigation was included in the 1997 NRA for LBA-Ecology).

For reasons of cost and schedule risk, development of new remote sensing instruments will be non-responsive to this NRA and will not be considered. However, minor refinements or adaptations of existing instruments to operate in the Amazonian environment, on a particular aircraft platform, and/or to comply with Brazilian laws are acceptable and even encouraged, provided costs are modest and reasonable.

In addition, NASA will not take responsibility for deployment of non-U.S. aircraft to South America; proposals for such research activities will be non-responsive to this NRA and will not be considered. (Investigators seeking to propose non-U.S., non-host country aircraft flights for LBA should be prepared to seek involvement in LBA through direct interactions between the two governments involved.)

C. LBA-ECOLOGY PROJECT IMPLEMENTATION AND MANGEMENT

1. LBA-Ecology Project Office

NASA Headquarters has established a Project Office for LBA-Ecology led by the Goddard Space Flight Center. The NASA LBA-Ecology Project Office arranges for logistical support and the installation of infrastructure, including a data and information management system. It will be responsible for coordinating the U.S. airborne science campaigns for LBA-Ecology.

2. Science Team Membership

Investigators selected to conduct airborne science research under LBA-Ecology will become members of the LBA-Ecology Science Team. They will be expected to participate fully in all Science Team meetings and activities and to budget accordingly. Investigators should budget for two four-day meetings per year, nominally one in the U.S. and one in South America.

The LBA-Ecology Science Team will bear the primary responsibility for the scientific content, direction, and priorities within LBA-Ecology. The LBA-Ecology Science Team, in close consultation with the LBA Science Team, the LBA Central Office in Brazil, and the LBA-Ecology Project Office, will be responsible for finalizing the science plan for the LBA-Ecology airborne campaign(s); they will work with the LBA-Ecology Project Scientist and Project Office staff to keep current the LBA-Ecology Experiment Plan (<http://lba->

ecology.gsfc.nasa.gov/lbaeco/About_the_Project/explan/explanv1/explanv1.htm), detailing the specific activities to be conducted during the execution of LBA-Ecology.

3. Responsibilities of U.S. LBA-Ecology Investigators

The following constitute a minimum set of requirements for membership on the LBA-Ecology Science Team. These responsibilities were established in 1999 as a guide for new investigations proposing to become part of LBA, but apply equally well to investigators proposing under this NRA.

a. Science Content

Participation on the LBA-Ecology Science Team is open to scientists whose research falls under the LBA-Ecology goal and the plans and scientific questions outlined in the Experiment Plan for LBA-Ecology.

b. Collaboration with Host Country Scientists

Each LBA-Ecology investigation is required to include an effective collaboration with one or more scientists from the South American host country for the study. Involvement of Amazonian scientists is encouraged whenever possible.

c. Participation in Science Team Activities

LBA-Ecology is a team project. The purpose of uniting a team is to encourage mutual support and collaboration. The products of the team should be more valuable than the products of a similar number of individual investigations. In order to coordinate team activities, all investigators should participate in science team meetings and where appropriate small workshops. Investigators should work with the LBA-Ecology Project office as well as the overall LBA Central Office to coordinate their activities.

For practical purposes and based on the history of NASA funding, the LBA-Ecology team is divided into a number of sub-projects. For those projects with NASA funding, NASA requests that at least one representative investigator from S. America and one from the US attend each full science team meeting (normally 2 per year). Support for this participation is budgeted by the investigators from grant funds. Research teams not funded by NASA also are expected to send representatives to these coordination meetings. Participation in LBA Science Meetings is also expected.

d. Participation in Education and Training

All LBA-Ecology teams are required to participate in LBA-related training and education activities. There is no single formal requirement, however most teams will be involved in presenting seminars or short courses and training graduate students and technicians. The primary focus of training and education activities are project participants from South America, particularly those from the Amazon region.

e. Adherence to the LBA Data and Publication Policies

The LBA Science Steering Committee recommended data and publication policies are attached below (section V.C.4 of this appendix). The LBA-Ecology Science Team endorsed these policies. All LBA-Ecology participants should adhere to these policies. NASA-funded investigators must also follow NASA data policies (see section V.C.4 below).

4. LBA Data and Publication Policies

Current NASA policy does not allow for any period of exclusive use by either an individual scientist or a Science Team. Further, NASA intends to pursue a practice of timely release (i.e., as soon as is reasonably possible) for public access to data within the overall LBA partnership. The overall LBA data policy, reproduced below, is less strict, allowing for a period of up to a year for data release to the public. LBA-Ecology Science Team members are expected to adhere to both policies – using whichever is stricter as the overall guide.

LBA Data and Publication Policies, Approved by the LBA Science Steering Committee, May 13, 1998, Piracicaba, SP, Brazil

INTRODUCTION

LBA data policies are guided by the fundamental principle that cooperation and synergism should be maximized in all LBA activities. To ensure that all LBA participants have access to data in a timely manner and that appropriate credit is given to the investigators, there is a strong need for a definition of data policies that will be adopted by the entire LBA.

LBA data policies will guide data sharing, citation of data from other investigators, access to restricted data and promote the exchange of quality controlled / quality assured data. All LBA researchers must follow the national laws concerning export of all data gathered by foreign researchers of the various Amazonian countries, notably Brazil. The LBA home page and the project offices in Brazil can provide this information.

LBA data and publication policies:

1. Data generated by LBA will become public domain and will be permanently archived in Brazil. The LBA Data Information System (DIS) will provide tools for documenting, storing, searching and distributing these data.

2. All LBA data should be available to all LBA researchers. Exceptions may be made in the case of raw or preliminary data, for which distribution can be restricted for a limited period of time.

3. There will be no periods of exclusive rights to publish LBA results. Exceptions are possible for students where graduation requirements prohibit publication of results prior to acceptance of a Thesis.

4. Individual investigators may make their own data more widely available at any time. Outside investigators may be given access to this data as soon as the data have been submitted to the LBA DIS, with some prudent time period for quality control.

5. Each LBA module is responsible for establishing a time schedule for data exchange within the projects and data delivery to LBA DIS. The time limit for data delivery to LBA-DIS will be no more than one year.

6. Data should be analyzed cooperatively by all scientists involved in obtaining them. Especially cooperation across disciplines and among South American, European and North American researchers should be encouraged. Publications resulting from work under LBA should be co-authored by all scientists who have participated substantially in the work, unless some participants choose not to be on the authors' list. The same applies to presentations at meetings. Special effort by each non-South American researcher should be put into integration of South American researchers in their work and in the publication of the results.

7. Where data are used for modeling or integrating studies, the scientist collecting the data will be credited appropriately, either by co-authorship or by citation. Investigators using data provided by another investigator as a substantial component of a paper should offer the originating investigator co-authorship. In cases where data from other investigators are a minor contribution to a paper, the data should be referenced by a citation. Users of the data will always have to state the source of the data.

8. Specific constraints for certain data sources (e.g. satellite products, global meteorological analysis, etc) may be subject to copyright restrictions which are more limiting than this LBA data policy. It is up to the LBA-OIC to take the first steps in making contacts with officials and institutions in order to prepare specific agreements that will allow LBA scientists to use the data.

9. If conflicts do occur, they should be resolved at the level of the LBA modules.

5. LBA Data and Information System (LBA DIS)

An Internet-based approach for data and information management has been created for sharing scientific data in LBA. The LBA Data and Information System (LBA DIS) is a distributed system, consisting of LBA investigator web sites, LBA project web sites, and the Beija-flor system. The core of LBA DIS has two major components: the Beija-flor search and data sharing component and the LBA Metadata Editor (LME). By using World Wide Web, or simply "Web" technology, the combined capabilities of Beija-flor and the LME allow data and documentation to be stored on, and accessed from, the networked computers of individual scientists located around the world.

Currently, the LME facilitates the entry, editing, and storage of metadata in standard formats for use by Beija-flor. (Metadata is the information that describes the characteristics (e.g., geographic location, parameter names, date) of the various data sets. In the near future, full data set documentation capabilities will be integrated with the LME.) Beija-flor provides the needed data search and sharing functionality by harvesting and organizing metadata that are then accessed and reviewed by the users. Data providers and scientists use the LME to provide metadata to Beija-flor by saving the files of information in specified locations on their own or other Web-accessible computer systems and marking the file as "searchable". During its regular harvesting cycle (currently nightly), Beija-flor collects metadata from only the files that are marked as searchable. Each Beija-flor system node (currently at the Oak Ridge National Laboratory (ORNL) and the Brazilian Space Research Institute (INPE/CPTEC)) harvests metadata and builds a database of the harvested information. Harvested information is shared across the nodes so that users are able to search and review available metadata by accessing the Web-based Beija-flor and LME interfaces at any of the nodes with their Web-browser software. For more information, see the Beija-flor search page: <http://beija-flor.ornl.gov/servlet/lbaeco> and the LBA Metadata Editor: <http://daacl.esd.ornl.gov/cgi-bin/MDEDIT/access.pl>

The NASA-designated long-term archive for ecological and biogeochemical data from field campaigns is the Distributed Active Archive Center (DAAC) at ORNL. Thus, data collected through LBA-Ecology will be archived at the ORNL DAAC as well as in Brazil.

D. UNITED STATES - BRAZIL / SOUTH AMERICA FORMAL AGREEMENTS

NASA and the Ministry of Science and Technology of Brazil have executed an Implementing Arrangement under a framework agreement on science and technology between the U.S. and Brazil to formalize the scientific cooperation and secure the necessary approvals for conducting research under LBA-Ecology in Brazil. This implementing arrangement covers all investigations selected through the 1997 announcement for LBA-Ecology and a few others added after that date, but does not cover airborne science on U.S. aircraft. A new Implementing Arrangement will need to be executed in support of the investigations selected under this NRA. NASA intends to begin drafting this agreement as soon as the Notices of Intent (NOI) to propose have been received; the specific information on sensors and aircraft to be proposed that will be provided in the NOIs should be adequate to start this process. However, the new agreement cannot be finalized until after the announcement of the final selection. All of the activities and schedules discussed in this NRA are subject to the successful execution of this new Implementing Arrangement and obtaining all other necessary approvals. NASA also will seek to obtain any other required agreements/approvals from other South American countries that might be proposed for aircraft overflights.

APPENDIX B

AMENDATORY GUIDANCE TO THE GENERAL GUIDELINES CONTAINED IN APPENDIX C AND APPLICABLE ONLY TO THIS NRA AND INSTRUCTIONS FOR PROPOSERS

I. PURPOSE

These guidelines contain general and specific information regarding the submission of proposals in response to this NRA. Formats for submission of proposals for research related to this program are provided. The evaluation criteria are specified. Appendix C contains general instructions for responding to NASA Research Announcements. Where conflicts exist between this appendix and Appendix C, this appendix shall be the controlling document.

II. PROPOSAL CONTENT AND FORMAT

The proposal should provide sufficient detail to enable a reviewer to assess the value of the proposed research, its relation to the objectives of the NRA, and the probability that the investigators will be able to accomplish the stated objectives within the requested resources and schedule. Capabilities of the proposing organizations should be described including the experience of the Principal Investigator and any Co-Investigators. The technical part of the proposal should be limited to the equivalent of 15 pages of text (***10 pages for Type 2 Applications proposals***), single-spaced, with type no smaller than 12 pt. A reasonable number of figures and tables (not to exceed 4 pages) may be appended. Short resumes and statements of current and pending research funding (including proposal name, funding agency, duration, and total funding) for all investigators should be included. The cover sheet, table of contents, abstract, list of references, management plan, cost plan, ***data plan (for LBA-Ecology only)***, resumes, and statements of current and pending funding need not count in the technical plan page limit. The proposal should be self-contained, and should not refer reviewers to external sources or web-sites for critical information. Additional pertinent information (e.g., reprints, letters indicating the commitment of co-investigators and collaborators or international partners) may be added as appendices. If color is used, proposers should ensure that all copies have color. Proposals should not be bound or in covers.

A. PAGE LIMITS

Offerors should adhere to the following page limit recommendations:

| | |
|-------------------|-------|
| Cover Letter | 1 |
| Cover Page | 1 - 2 |
| Table of Contents | 1 |
| Abstract | 1 |

| | |
|---|---|
| Technical Plan | 15 |
| (FOR TYPE 2 APPLICATIONS PROPOSALS – 10) | |
| References | 1 - 2 |
| Management Plan | 1 – 2 |
| (FOR TYPE 2 APPLICATIONS PROPOSALS – 7) | |
| Data Plan | 2 – 5 (REQUIRED FOR LBA- ECOLOGY ONLY) |
| Cost Plan | 3 - 8 |
| Current and Pending Research | 1 – 2 per investigator |
| Resumes | 1 - 2 per investigator |
| Other | As few as possible |

Where page length requirements differ for science versus applications proposals, it will be acceptable for joint science and applications proposals to adhere to whichever page limit is larger.

B. CONTENT

Each proposal should contain the following materials assembled in the order given.

1. Cover Letter. Each proposal should be prefaced by a cover letter signed by an official of the investigator's institution who is authorized to legally bind the organization to the proposal and its content (unless the signature appears on the proposal itself). The cover letter should refer to the Carbon NRA.
2. Proposal Cover Page. Please see Appendix D. The NRA component (i.e., research area) addressed by the proposal should be indicated on the cover page. In most cases, only one research area should be indicated; however, joint science and applications proposals will be welcome for joint review. *Please note that the budget request to be summarized on the cover page should be for the entire investigation, totaling the budget requests for all institutions participating in the proposal.*
3. Table of Contents (recommended length: 1 page). A table of contents listing the page numbers for key sections of the proposal, including the cost and management plans, should be provided.
4. Abstract (length must not exceed 1 page). The abstract should summarize the research proposed in one page or less. It should contain a simple, concise overview of the investigation, its objectives, its scientific approach, expected results, and the value of its results to NASA's Carbon NRA efforts. It is very important that this abstract be specific and accurately represent the research to be conducted.
5. Technical Plan (length must not exceed 15 pages; **FOR TYPE 2 APPLICATIONS PROPOSALS, length must not exceed 10 pages**). The main body of the proposal should contain a full statement of the research to be undertaken and should describe key background, objectives, scientific or applications relevance, technical approach, and

expected significance of the work. The key elements of the project should be clearly identified and related to each other. The methods or approaches to be used should be described, and, as appropriate, the advantages of the selected methods or approaches over alternatives should be discussed. The anticipated results should be identified and their relation to the proposal's stated objectives and NASA's objectives, as outlined in the NRA, should be discussed. The research should be described in sufficient detail that peer reviewers can adequately assess the scientific methods and quality of the work proposed. Where resources from satellites or other data sources (e.g., aircraft sensors) are required, proposals should indicate whether a commitment has been made for access to the other systems or whether the required/desired data are available. The costs for such data should be included in the cost plan. The plan should also describe how any data products to be created or additional, ancillary data sets to be obtained will be shared with NASA, other investigators, and the broader scientific and user communities. ***FOR LBA-ECOLOGY ONLY, data issues should be covered in the Data Plan (see item 7.5 below).***

6. References (recommended length: 1-2 pages). A complete list of references cited in the technical plan must be provided. Each reference should include the title, names of all authors, book or journal, volume number, page numbers, and year of publication. While it is important to be concise, proposers should follow accepted scholarly practices in providing citations for source materials relied upon when preparing any section of the proposal.

7. Management Plan (recommended length: 1/2 - 2 pages, depending on complexity; ***FOR TYPE 2 APPLICATIONS PROPOSALS, recommended length: 7 pages***). The Management Plan should outline the roles and responsibilities of all investigators and collaborators and indicate the relationships among these roles and responsibilities within the group. The management plan should also identify what contractor and/or non-institutional support is anticipated and who will be providing it. A schedule for reporting results and publishing papers should be described.

FOR TYPE 2 APPLICATIONS PROPOSALS ONLY: the management plan must include a description and analysis of how application implementation will transition from development to operations. The plan should indicate how operational support will be provided when NASA assumes a non-funding role in the project, and a plan for on-going operational support.

REQUIRED FOR LBA-ECOLOGY ONLY: 7.5. Data Plan. All proposals should provide a brief Data Plan describing the investigator's commitment to the LBA Data Policy and plans for sharing data and for interacting with the LBA Data and Information System (LBA DIS). This plan should describe, in a general way, the data to be collected and how it will be handled, processed, quality checked, and made available to other LBA investigators. Procedures for delivering to Brazil the original data (or an exact duplicate copy) of data acquired over Brazil prior to leaving the country must be detailed. A rough schedule for delivery of processed data products to the LBA DIS should be provided. Estimates of the type and amount of data to be requested from the data system and/or other investigators and the desired time of

delivery should be described. If data from other LBA investigations will be required, these measurements should be listed in the Data Plan. Resources (i.e., personnel and equipment) for supporting the Data Plan should be identified in the Cost Plan.

8. Cost Plan for U.S. Proposals Only. Please see Appendix C for additional guidance and Appendix D for forms. Contributions from any cost-sharing plan or other support for the proposed research should be detailed.

FOR APPLICATIONS ONLY: Applications proposals (Types 1 and 2) are expected to include a cost-sharing plan.

Costs for the acquisition, purchase, storage, or processing of all required data should be included. Also, costs for modeling, if proposed, should include all aspects of the process from writing software through computer operations and time. If use of NASA or other supercomputer resources is anticipated, an estimate of computational requirements should be included as part of the budget submission. Requirements for any data from NASA's commercial data buy should be clearly specified. Full costs for the purchase of data from commercial sources should be included in the budget and the requirement documented in the proposal.

REQUIRED FOR LCLUC ONLY: Proposers offering LCLUC research should budget for one team meeting per year to be held in the Washington, DC area.

REQUIRED FOR LBA-ECOLOGY ONLY: The LBA-Ecology Project Office will provide logistical support to the LBA-Ecology Science Team and will work to efficiently provide field infrastructure and to seek economies of scale that will minimize costs. Needed logistical support and infrastructure for the airborne campaign(s) will be provided; special support for individual investigations must be described and budgeted for in individual proposals, but some or all of it may be pulled out post-selection for implementation by the Project Office. Proposers are urged to delineate these needs separately in their budget if at all possible. If difficulties arise in estimating costs for requested Project logistical and infrastructural support, proposers should at least describe their needs in sufficient detail that Project staff can evaluate the requirement. Selected scientists should expect to negotiate with the Project Manager to ensure that their infrastructural and logistical needs are met adequately and in a cost-effective manner. Participation in LBA-Ecology Science Team activities must be accounted for in each investigator's Cost Plan. Investigators should budget for two four-day meetings per year, nominally one in the U.S. and one in South America.

9. Summary of Current and Pending Funding. A list of current and pending research funding, to include the proposal name, funding agency, duration of research project, and total funding level, for all investigators should be included. NSF form 1239 may be used (it can be accessed at: <http://www.nsf.gov/pubs/2000/00form1239/doc>).

10. Resumes. Brief resumes (1-2 pages) for all named investigators should be appended to the proposal.

11. Other Enclosures. Any other material pertinent to the consideration of the proposal may be attached as an appendix. This might include preprints or reprints of relevant publications, background on new measurement or analysis approaches, or letters of support and/or participation by scientists and/or institutions. However, reviewers will be under no obligation to read this material, so critical information should be included in the main body of the proposal. Inclusion of general materials that will not aid in the evaluation of the proposal is specifically discouraged.

III. SELECTION PROCESS AND EVALUATION CRITERIA

The review of proposals submitted under this NRA will consist of a full peer review including external reviewers, which may involve a mail review, a panel review, or both. This will be followed by a programmatic review in which NASA managers will assess program balance across the competitive-range proposals and evaluate any logistical, implementation, cost, and/or management concerns.

Proposals that address science will be reviewed by scientific experts. Proposals that address applications will be reviewed by persons familiar with the application and operational use of remote sensing, GIS, and related technologies.

A. EVALUATION CRITERIA

The criteria listed below will be used in evaluating individual proposals. These criteria supersede those listed in section (i) of Appendix C, and are of approximately equal importance.

1. The intrinsic merits of the investigation, including:

(a) the overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.

(b) the qualifications, capabilities, and relevant experience of the Principal Investigator and any Co-Investigators or collaborators as an indication of their ability to carry the investigation to a successful conclusion within the requested resources, including timely publication of peer-reviewed journal articles.

(c) the adequacy of facilities and ability and commitment of the investigator's institution to provide the necessary

support to ensure that the investigation can be completed satisfactorily.

FOR APPLICATIONS ONLY: (d) end-user involvement in project initiation, requirement definition, and application evaluation and testing, and participation of the private sector in data acquisition, product development, and operations.

2. The relevance and responsiveness of the proposed research to the goals and objectives of NASA's Earth Science Enterprise and to the goals and objectives described in this NRA, including:

(a) the probability of achieving one or more significant objectives directly relevant to the research areas identified in this NRA.

(b) the soundness, logic, and practicality of the proposed technical methods and concepts for achieving successful results.

(c) the potential benefits to future U.S. Earth Science missions or data purchases.

(d) the quality, effectiveness, and appropriateness of the management plan. ***(FOR LBA-ECOLOGY ONLY: (also) the quality, effectiveness, and appropriateness of the data plan, the training and education component, and the strategy for involving host country collaborators.)***

FOR LBA-ECOLOGY ONLY: (e) the overall importance of the airborne observation to be made and/or data product to be produced to the goals and objectives of LBA-Ecology.

FOR APPLICATIONS PROPOSALS ONLY: (e) the quality, effectiveness, and appropriateness of the applications approach, including: (1) national importance, (2) pervasiveness, (3) uniqueness of NASA ESE contribution, (4) partnership investment/involvement, (5) documentable results, and (6) commercial impact.

3. The cost of the investigation, including consideration of the realism and reasonableness of the proposed cost, the relationship of the proposed cost to available funds, and the potential value of the research results (i.e.,

cost/benefit) to the user community. (***FOR APPLICATIONS ONLY: (also) the degree of cost sharing among project participants and, for Type 2 Applications proposals, the soundness of the funding plan for transition from application implementation to operations.***)

B. OTHER CONSIDERATIONS

NASA reserves the right to select and make an award covering only a portion of a proposer's investigation, in which case the investigator will be given the opportunity to accept or decline such partial acceptance. In cases in which two or more proposals address similar problems and/or adopt similar approaches to data analysis, NASA may desire joint participation on the part of two or more proposers in a single project. If such overlap involves more than one funding organization, NASA and those organizations will confer and mutually agree to the disposition of those proposals.

Any negotiations prior to final decisions will occur only after the peer review of proposals has been completed. The final decisions will be made by the NASA selecting official(s) based on the results of the peer review and programmatic considerations, including the program's focus, goals, and balance. Final decisions will be made promptly and investigators will be notified by either electronic mail or surface mail, or both. Proposers will receive anonymous copies of the reviews for their proposal(s).

APPENDIX C

INSTRUCTIONS FOR RESPONDING TO NASA RESEARCH ANNOUNCEMENTS

NASA Federal Acquisition Regulation (FAR), Supplement (NFS) Part 1852.235-72, Effective JANUARY 2000

(a) General.

(1) Proposals received in response to a NASA Research Announcement (NRA) will be used only for evaluation purposes. NASA does not allow a proposal, the contents of which are not available without restriction from another source, or any unique ideas submitted in response to an NRA to be used as the basis of a solicitation or in negotiation with other organizations, nor is a pre-award synopsis published for individual proposals.

(2) A solicited proposal that results in a NASA award becomes part of the record of that transaction and may be available to the public on specific request; however, information or material that NASA and the awardee mutually agree to be of a privileged nature will be held in confidence to the extent permitted by law, including the Freedom of Information Act.

(3) NRAs contain programmatic information and certain requirements which apply only to proposals prepared in response to that particular announcement. These instructions contain the general proposal preparation information which applies to responses to all NRAs.

(4) A contract, grant, cooperative agreement, or other agreement may be used to accomplish an effort funded in response to an NRA. NASA will determine the appropriate instrument. Contracts resulting from NRAs are subject to the Federal Acquisition Regulation and the NASA FAR Supplement. Any resultant grants or cooperative agreements will be awarded and administered in accordance with the NASA Grant and Cooperative Agreement Handbook (NPG 5800.1).

(5) NASA does not have mandatory forms or formats for responses to NRAs; however, it is requested that proposals conform to the guidelines in these instructions. NASA may accept proposals without discussion; hence, proposals should initially be as complete as possible and be submitted on the proposers' most favorable terms.

(6) To be considered for award, a submission must, at a minimum, present a specific project within the areas delineated by the NRA; contain sufficient technical and cost information to permit a meaningful evaluation; be signed by an official authorized to legally bind the submitting organization; not merely offer to perform standard services or to just provide computer facilities or services; and not significantly duplicate a more specific current or pending NASA solicitation.

(b) NRA-Specific Items.

Several proposal submission items appear in the NRA itself: the unique NRA identifier; when to submit proposals; where to send proposals; number of copies required; and sources for more information. Items included in these instructions may be supplemented by the NRA.

(c) The following information is needed to permit consideration in an objective manner. NRAs will generally specify topics for which additional information or greater detail is desirable. Each proposal copy shall contain all submitted material, including a copy of the transmittal letter if it contains substantive information.

(1) Transmittal Letter or Prefatory Material.

- (i) The legal name and address of the organization and specific division or campus identification if part of a larger organization;
- (ii) A brief, scientifically valid project title intelligible to a scientifically literate reader and suitable for use in the public press;
- (iii) Type of organization: e.g., profit, nonprofit, educational, small business, minority, women-owned, etc.;
- (iv) Name and telephone number of the principal investigator and business personnel who may be contacted during evaluation or negotiation;
- (v) Identification of other organizations that are currently evaluating a proposal for the same efforts;
- (vi) Identification of the NRA, by number and title, to which the proposal is responding;
- (vii) Dollar amount requested, desired starting date, and duration of project;
- (viii) Date of submission; and
- (ix) Signature of a responsible official or authorized representative of the organization, or any other person authorized to legally bind the organization (unless the signature appears on the proposal itself).

(2) Restriction on Use and Disclosure of Proposal Information. Information contained in proposals is used for evaluation purposes only. Offerors or quoters should, in order to maximize protection of trade secrets or other information that is confidential or privileged, place the following notice on the title page of the proposal and specify the information subject to the notice by inserting an appropriate identification in the notice. In any event, information contained in proposals will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice.

**Notice
Restriction on Use and Disclosure of Proposal Information**

The information (data) contained in *[insert page numbers or other identification]* of this proposal constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other agreement) is awarded on the basis of this proposal the Government shall have the right to use and disclose this information (data) to the extent provided in the contract (or other agreement). This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

(3) **Abstract.** Include a concise (200-300 word if not otherwise specified in the NRA) abstract describing the objective and the method of approach.

(4) **Project Description.**

(i) The main body of the proposal shall be a detailed statement of the work to be undertaken and should include objectives and expected significance; relation to the present state of knowledge; and relation to previous work done on the project and to related work in progress elsewhere. The statement should outline the plan of work, including the broad design of experiments to be undertaken and a description of experimental methods and procedures. The project description should address the evaluation factors in these instructions and any specific factors in the NRA. Any substantial collaboration with individuals not referred to in the budget or use of consultants should be described. Subcontracting significant portions of a research project is discouraged.

(ii) When it is expected that the effort will require more than one year, the proposal should cover the complete project to the extent that it can be reasonably anticipated. Principal emphasis should be on the first year of work, and the description should distinguish clearly between the first year's work and work planned for subsequent years.

(5) **Management Approach.** For large or complex efforts involving interactions among numerous individuals or other organizations, plans for distribution of responsibilities and - arrangements for ensuring a coordinated effort should be described.

(6) **Personnel.** The principal investigator is responsible for supervision of the work and participates in the conduct of the research regardless of whether or not compensated under the award. A short biographical sketch of the principal investigator, a list of principal publications and any exceptional qualifications should be included. Omit social security number and other personal items which do not merit consideration in evaluation of the proposal. Give similar biographical information on other senior professional personnel who will be directly associated with the project. Give the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants,

together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

(7) Facilities and Equipment.

(i) Describe available facilities and major items of equipment especially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any Government-owned facilities, industrial plant equipment, or special tooling that are proposed for use. Include evidence of its availability and the cognizant Government points of contact.

(ii) Before requesting a major item of capital equipment, the proposer should determine if sharing or loan of equipment already within the organization is a feasible alternative. Where such arrangements cannot be made, the proposal should so state. The need for items that typically can be used for research and non-research purposes should be explained.

(8) Proposed Costs (U.S. Proposals Only).

(i) Proposals should contain cost and technical parts in one volume: do not use separate "confidential" salary pages. As applicable, include separate cost estimates for salaries and wages; fringe benefits; equipment; expendable materials and supplies; services; domestic and foreign travel; ADP expenses; publication or page charges; consultants; subcontracts; other miscellaneous identifiable direct costs; and indirect costs. List salaries and wages in appropriate organizational categories (e.g., principal investigator, other scientific and engineering professionals, graduate students, research assistants, and technicians and other non-professional personnel). Estimate all staffing data in terms of staff-months or fractions of full-time.

(ii) Explanatory notes should accompany the cost proposal to provide identification and estimated cost of major capital equipment items to be acquired; purpose and estimated number and lengths of trips planned; basis for indirect cost computation (including date of most recent negotiation and cognizant agency); and clarification of other items in the cost proposal that are not self-evident. List estimated expenses as yearly requirements by major work phases.

(iii) Allowable costs are governed by FAR Part 31 and the NASA FAR Supplement Part 1831 (and OMB Circulars A-21 for educational institutions and A-122 for nonprofit organizations).

(iv) Use of NASA funds--NASA funding may not be used for foreign research efforts at any level, whether as a collaborator or a subcontract. The direct purchase of supplies and/or services, which do not constitute research, from non-U.S. sources by U.S. award recipients is permitted. Additionally, in accordance with the National Space Transportation Policy, use of a non-U.S. manufactured launch vehicle is permitted only on a no-exchange-of-funds basis.

(9) **Security.** Proposals should not contain security classified material. If the research requires access to or may generate security classified information, the submitter will be required to comply with Government security regulations.

(10) **Current Support.** For other current projects being conducted by the principal investigator, provide title of project, sponsoring agency, and ending date.

(11) **Special Matters.**

(i) Include any required statements of environmental impact of the research, human subject or animal care provisions, conflict of interest, or on such other topics as may be required by the nature of the effort and current statutes, executive orders, or other current Government-wide guidelines.

(ii) Proposers should include a brief description of the organization, its facilities, and previous work experience in the field of the proposal. Identify the cognizant Government audit agency, inspection agency, and administrative contracting officer, when applicable.

(d) **Renewal Proposals.**

(1) Renewal proposals for existing awards will be considered in the same manner as proposals for new endeavors. A renewal proposal should not repeat all of the information that was in the original proposal. The renewal proposal should refer to its predecessor, update the parts that are no longer current, and indicate what elements of the research are expected to be covered during the period for which support is desired. A description of any significant findings since the most recent progress report should be included. The renewal proposal should treat, in reasonable detail, the plans for the next period, contain a cost estimate, and otherwise adhere to these instructions.

(2) NASA may renew an effort either through amendment of an existing contract or by a new award.

(e) **Length.** Unless otherwise specified in the NRA, effort should be made to keep proposals as brief as possible, concentrating on substantive material. Few proposals need exceed 15-20 pages. Necessary detailed information, such as reprints, should be included as attachments. A complete set of attachments is necessary for each copy of the proposal. As proposals are not returned, avoid use of "one-of-a-kind" attachments.

(f) **Joint Proposals.**

(1) Where multiple organizations are involved, the proposal may be submitted by only one of them. It should clearly describe the role to be played by the other organizations and indicate the legal and managerial arrangements contemplated. In other instances, simultaneous submission of related proposals from each organization might be appropriate, in which case parallel awards would be made.

(2) Where a project of a cooperative nature with NASA is contemplated, describe the contributions expected from any participating NASA investigator and agency facilities or equipment which may be required. The proposal must be confined only to that which the proposing organization can commit itself. "Joint" proposals which specify the internal arrangements NASA will actually make are not acceptable as a means of establishing an agency commitment.

(g) **Late Proposals.** Proposals or proposal modifications received after the latest date specified for receipt may be considered if a significant reduction in cost to the Government is probable or if there are significant technical advantages, as compared with proposals previously received.

(h) **Withdrawal.** Proposals may be withdrawn by the proposer at any time before award. Offerors are requested to notify NASA if the proposal is funded by another organization or of other changed circumstances which dictate termination of evaluation.

(i) **Evaluation Factors.**

(1) Unless otherwise specified in the NRA, the principal elements (of approximately equal weight) considered in evaluating a proposal are its relevance to NASA's objectives, intrinsic merit, and cost.

(2) Evaluation of a proposal's relevance to NASA's objectives includes the consideration of the potential contribution of the effort to NASA's mission.

(3) Evaluation of its intrinsic merit includes the consideration of the following factors of equal importance:

(i) Overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.

(ii) Offeror's capabilities, related experience, facilities, techniques, or unique combinations of these which are integral factors for achieving the proposal objectives.

(iii) The qualifications, capabilities, and experience of the proposed principal investigator, team leader, or key personnel critical in achieving the proposal objectives.

(iv) Overall standing among similar proposals and/or evaluation against the state-of-the-art.

(4) Evaluation of the cost of a proposed effort may include the realism and reasonableness of the proposed cost and available funds.

(j) **Evaluation Techniques.** Selection decisions will be made following peer and/or scientific review of the proposals. Several evaluation techniques are regularly used within

NASA. In all cases proposals are subject to scientific review by discipline specialists in the area of the proposal. Some proposals are reviewed entirely in-house, others are evaluated by a combination of in-house and selected external reviewers, while yet others are subject to the full external peer review technique (with due regard for conflict-of-interest and protection of proposal information), such as by mail or through assembled panels. The final decisions are made by a NASA selecting official. A proposal which is scientifically and programmatically meritorious, but not selected for award during its initial review, may be included in subsequent reviews unless the proposer requests otherwise.

(k) Selection for Award.

(1) When a proposal is not selected for award, the proposer will be notified. NASA will explain generally why the proposal was not selected. Proposers desiring additional information may contact the selecting official who will arrange a debriefing.

(2) When a proposal is selected for award, negotiation and award will be handled by the procurement office in the funding installation. The proposal is used as the basis for negotiation. The contracting officer may request certain business data and may forward a model award instrument and other information pertinent to negotiation.

(l) Additional Guidelines Applicable to Foreign Proposals and Proposals Including Foreign Participation.

(1) NASA welcomes proposals from outside the U.S. However, foreign entities are generally not eligible for funding from NASA. Therefore, unless otherwise noted in the NRA, proposals from foreign entities should not include a cost plan unless the proposal involves collaboration with a U.S. institution, in which case a cost plan for only the participation of the U.S. entity must be included. Proposals from foreign entities and proposals from U.S. entities that include foreign participation must be endorsed by the respective government agency or funding/sponsoring institution in the country from which the foreign entity is proposing. Such endorsement should indicate that the proposal merits careful consideration by NASA and, if the proposal is selected, sufficient funds will be made available to undertake the activity as proposed.

(2) All foreign proposals must be typewritten in English and comply with all other submission requirements stated in the NRA. All foreign proposals will undergo the same evaluation and selection process as those originating in the U.S. All proposals must be received before the established closing date. Those received after the closing date will be treated in accordance with paragraph (g) of this provision. Sponsoring foreign government agencies or funding institutions may, in exceptional situations, forward a proposal without endorsement if endorsement is not possible before the announced closing date. In such cases, the NASA sponsoring office should be advised when a decision on endorsement can be expected.

(3) Successful and unsuccessful foreign entities will be contacted directly by the NASA sponsoring office. Copies of these letters will be sent to the foreign sponsor. Should a

foreign proposal or a U.S. proposal with foreign participation be selected, NASA's Office of External Relations will arrange with the foreign sponsor for the proposed participation on a no-exchange-of-funds basis, in which NASA and the non-U.S. sponsoring agency or funding institution will each bear the cost of discharging their respective responsibilities.

(4) Depending on the nature and extent of the proposed cooperation, these arrangements may entail:

- (i) An exchange of letters between NASA and the foreign sponsor; or
- (ii) A formal Agency-to-Agency Memorandum of Understanding (MOU).

(m) Export Control Guidelines Applicable to Foreign Proposals and Proposals Including Foreign Participation.

(1) Foreign proposals and proposals including foreign participation must include a section discussing compliance with U.S. export laws and regulations, e.g., 22 CFR Parts 120-130 and 15 CFR Parts 730-774, as applicable to the circumstances surrounding the particular foreign participation. The discussion must describe in detail the proposed foreign participation and is to include, but not limited to, whether or not the foreign participation may require the prospective proposer to obtain the prior approval of the Department of State or the Department of Commerce via a technical assistance agreement or an export license, or whether a license exemption/exception may apply. If prior approvals via licenses are necessary, discuss whether the license has been applied for or if not, the projected timing of the application and any implications for the schedule. Information regarding U.S. export regulations is available at <http://www.pmdtc.org> and <http://www.bxa.doc.gov>. Proposers are advised that under U.S. law and regulations, spacecraft and their specifically designed, modified, or configured systems, components, and parts are generally considered "Defense Articles" on the United States Munitions List and subject to the provisions of the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120-130.

(n) Cancellation of NRA.

(1) NASA reserves the right to make no awards under this NRA and to cancel this NRA. NASA assumes no liability for canceling the NRA or for anyone's failure to receive actual notice of cancellation.

(End of provision)

APPENDIX D

PROPOSAL COVER SHEET, REQUIRED DECLARATIONS, AND BUDGET SUMMARY FORM

Proposal Cover Sheet

NASA Research Announcement 00-OES-08

Proposal No. _____ (Leave Blank for NASA Use)

Research Area: Carbon Cycle Science (including Terrestrial Ecology) _____
(please check one; Other Terrestrial Ecology Research _____
however, joint science LCLUC: _____
and applications is OK) Applications: Type 1 _____ Type 2 _____
LBA-Ecology Airborne Science _____

Title: _____

Principal Investigator: _____

Department: _____

Institution: _____

Street/PO Box: _____

City: _____ State: _____ Zip: _____

Country: _____ Congressional District: _____

(used for database sorting purposes only)

E-mail: _____

Telephone: _____ Fax: _____

Co-Investigators:

| Name | Institution & E-mail Address | Address & Telephone |
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|------|------------------------------|---------------------|

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Budget:

1st Year: _____ 2nd Year: _____ 3rd Year: _____ Total: _____

By submitting the proposal identified in this *Cover Sheet/Proposal Summary* in response to this Research Announcement, the Authorizing Official of the proposing institution (or the individual proposer if there is no proposing institution) as identified below:

- certifies that the statements made in this proposal are true and complete to the best of his/her knowledge;
- agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal; and
- confirms compliance with all provisions, rules, and stipulations set forth in the two Certifications contained in this NRA [namely, (i) *Certification of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs*, and (ii) *Certifications, Disclosures, And Assurances Regarding Lobbying and Debarment & Suspension*].

Willful provision of false information in this proposal and/or its supporting documents, or in reports required under an ensuing award, is a criminal offense (U.S. Code, Title 18, Section 1001).

Title of Authorizing Institutional Official: _____

Signature: _____ Date: _____

Name of Proposing Institution: _____

Telephone: _____ E-mail: _____ Facsimile: _____

**Certification of Compliance with the NASA Regulations Pursuant to
Nondiscrimination in Federally Assisted Programs**

The (*Institution, corporation, firm, or other organization on whose behalf this assurance is signed, hereinafter called "Applicant "*) hereby agrees that it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), Title IX of the Education Amendments of 1962 (20 U.S.C. 1680 et seq.), Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and the Age Discrimination Act of 1975 (42 U.S.C. 16101 et seq.), and all requirements imposed by or pursuant to the Regulation of the National Aeronautics and Space Administration (14 CFR Part 1250) (hereinafter called "NASA") issued pursuant to these laws, to the end that in accordance with these laws and regulations, no person in the United States shall, on the basis of race, color, national origin, sex, handicapped condition, or age be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives federal financial assistance from NASA; and hereby give assurance that it will immediately take any measure necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of federal financial assistance extended to the Applicant by NASA, this assurance shall obligate the Applicant, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant for the period during which the federal financial assistance is extended to it by NASA.

This assurance is given in consideration of and for the purpose of obtaining any and all federal grants, loans, contracts, property, discounts, or other federal financial assistance extended after the date hereof to the Applicant by NASA, including installment payments after such date on account of applications for federal financial assistance which were approved before such date. The Applicant recognized and agrees that such federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign on behalf of the Applicant.

NASA FORM 1206

CERTIFICATIONS, DISCLOSURES, AND ASSURANCES REGARDING LOBBYING AND DEBARMENT & SUSPENSION

1. LOBBYING

As required by Section 1352, Title 31 of the U.S. Code, and implemented at 14 CFR Part 1271, as defined at 14 CFR Subparts 1271.110 and 1260.117, with each submission that initiates agency consideration of such applicant for award of a Federal contract, grant, or cooperative agreement exceeding \$ 100,000, the applicant must **certify** that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit a Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

2. GOVERNMENTWIDE DEBARMENT AND SUSPENSION

As required by Executive Order 12549, and implemented at 14 CFR 1260.510, for prospective participants in primary covered transactions, as defined at 14 CFR Subparts 1265.510 and 1260.117—

(1) The prospective primary participant **certifies** to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

BUDGET SUMMARY

For period from _____ to _____

- Provide a complete Budget Summary for year one and separate estimates for each subsequent year.
- Enter the proposed estimated costs in Column A (Columns B & C for NASA use only).
- Provide as attachments detailed computations of all estimates in each cost category with narratives as required to fully explain each proposed cost. See *Instructions For Budget Summary* on following page for details.

| | A | NASA USE ONLY | |
|---|---|---------------|---|
| | | B | C |
| 1. <u>Direct Labor</u> (salaries, wages, and fringe benefits) | | | |
| 2. <u>Other Direct Costs:</u> | | | |
| a. Subcontracts | | | |
| b. Consultants | | | |
| c. Equipment | | | |
| d. Supplies | | | |
| e. Travel | | | |
| f. Other | | | |
| 3. <u>Facilities and Administrative Costs</u> | | | |
| 4. <u>Other Applicable Costs:</u> | | | |
| 5. <u>SUBTOTAL--Estimated Costs</u> | | | |
| 6. <u>Less Proposed Cost Sharing</u> (if any) _____ | | | |
| 7. <u>Carryover Funds</u> (if any) | | | |
| a. Anticipated amount : _____ | | | |
| b. Amount used to reduce budget | | | |
| 8. <u>Total Estimated Costs</u> | | | |
| 9. <u>APPROVED BUDGET</u> | | | |

INSTRUCTIONS FOR BUDGET SUMMARY

1. Direct Labor (salaries, wages, and fringe benefits): Attachments should list the number and titles of personnel, amounts of time to be devoted to the grant, and rates of pay.
2. Other Direct Costs:
 - a. Subcontracts: Attachments should describe the work to be subcontracted, estimated amount, recipient (if known), and the reason for subcontracting.
 - b. Consultants: Identify consultants to be used, why they are necessary, the time they will spend on the project, and rates of pay (not to exceed the equivalent of the daily rate for Level IV of the Executive Schedule, exclusive of expenses and indirect costs).
 - c. Equipment: List separately. Explain the need for items costing more than \$5,000. Describe basis for estimated cost. General purpose equipment is not allowable as a direct cost unless specifically approved by the NASA Grant Officer. Any equipment purchase requested to be made as a direct charge under this award must include the equipment description, how it will be used in the conduct of the basic research proposed and why it cannot be purchased with indirect funds.
 - d. Supplies: Provide general categories of needed supplies, the method of acquisition, and the estimated cost.
 - e. Travel: Describe the purpose of the proposed travel in relation to the grant and provide the basis of estimate, including information on destination and number of travelers where known.
 - f. Other: Enter the total of direct costs not covered by 2a through 2e. Attach an itemized list explaining the need for each item and the basis for the estimate.
3. Facilities and Administrative (F&A) Costs: Identify F&A cost rate(s) and base(s) as approved by the cognizant Federal agency, including the effective period of the rate. Provide the name, address, and telephone number of the Federal agency official having cognizance. If unapproved rates are used, explain why, and include the computational basis for the indirect expense pool and corresponding allocation base for each rate.
4. Other Applicable Costs: Enter total explaining the need for each item.
5. Subtotal-Estimated Costs: Enter the sum of items 1 through 4.
6. Less Proposed Cost Sharing (if any): Enter any amount proposed. If cost sharing is based on specific cost items, identify each item and amount in an attachment.
7. Carryover Funds (if any): Enter the dollar amount of any funds expected to be available for carryover from the prior budget period. Identify how the funds will be used if they are not used to reduce the budget. NASA officials will decide whether to use all or part of the anticipated carryover to reduce the budget (not applicable to 2nd-year and subsequent-year budgets submitted for award of a multiple year award).
8. Total Estimated Costs: Enter the total after subtracting items 6 and 7b from item 5.

APPENDIX E

ELECTRONIC ADDRESSES

The URL references listed below are available for on-line access via the following World Wide Web Home Pages:

- (1) NASA Earth Science Enterprise Home Page:
<http://www.earth.nasa.gov/>
- (2) U.S. Carbon Cycle Science Interagency Working Group Home Page:
<http://www.carboncyclescience.gov/>
- (3) LCLUC Home Page:
<http://lcluc.gsfc.nasa.gov/>
- (4) Landsat Program Home Page:
<http://geo.arc.nasa.gov/sge/landsat/landsat.html>
- (5) LBA-Ecology Home Page:
<http://lba-ecology.gsfc.nasa.gov/lbaeco/>
- (6) LBA-Ecology Experiment Plan:
[http://lba-ecology.gsfc.nasa.gov/lbaeco/About the Project/explan/explanv1/explanv1.htm](http://lba-ecology.gsfc.nasa.gov/lbaeco/About%20the%20Project/explan/explanv1/explanv1.htm)
- (7) LBA Home Page:
http://www-eosdis.ornl.gov/lba_cptec/
- (8) NASA Airborne Science Program:
<http://www.dfrc.nasa.gov/airsci/>
- (9) Earth Observing System Terra Home Pages:
<http://modarch.gsfc.nasa.gov/MODIS/>
<http://terra.nasa.gov/>
<http://earthobservatory.nasa.gov/>
- (10) NASA CRSP Home Page:
<http://www.crsp.ssc.nasa.gov/databuy/dbmain.htm>

APPENDIX F

INSTRUCTIONS FOR SUBMITTING NOTICE OF INTENT

All prospective proposers are strongly encouraged to submit a notice of intent in response to this announcement. This will allow us to alert a peer review staff to adequately cover the proposal review process. The notice of intent should be submitted via email to *OESresponse@hq.nasa.gov* or fax to 202-479-0511. The notice of intent should include the following information:

- PI and CoI names and addresses, (including Zip + 4);
- Title of proposal;
- Telephone number;
- Fax number;
- Email address; and
- A brief summary of what you plan to propose (Please limit this to no more than 3000 characters).